DESCR

OF

PLANISP

PERFORM

I. In ASTRONOM
tions of the GLOBE
Declination, Right and Obl
and their Difference, Amplitude,
Hour, Azimuth, &c. as also
for any Star or Planet,

II. In the *Astronomical* Part of
GY, readily finding the Cusps
Circles of Position, Ark of
the other Requisites, as by
MOBILE. With several
that Elaborate Work of

III. On the Limb of it are Grad
Circles of Proportion, viz. Numbers,
Tangents, and Versed Sines. By which
the *Instrument* is rendred Univers
the forementioned Problems
lated to any Latitude.

And Lastly, You have sundry
Lines in Arithmetick, Geometry,

The Planisphere 17 Inches

By *R.* BARKER

Licens'd, *January* 30. 169

LONDON

Printed by

To the truly

Honourable and ever Loyal

Sir *EDWARD DERING*,

OF

Sharsted, in the *County* of *Kent*, Kt. One of *His Majesties* Commissioners of the Peace for the said *County*, and *Deputy-Governour* (under the Right Honourable the Lord *CHURCHILL*, *Governour*) of the Honourable the *Hudsons-Bay* Company.

Honoured Sir,

Your general Knowledge in all Arts, and Kindness to the Professors thereof, hath encouraged me in all humility to devote this small Tract to your generous Patronage and Protection.

I may with a modest Assurance aver, That this Planisphere *will, in* Astronomy, Astrology, Geometry *and* Dyalling, *prove a great Assistance to the ingenious Artist; and abbreviate much of his Toyl and Labour in those Ancient and Noble Sciences.*

Sir, This little Peice, intended for publick Use and Profit, is prostrate before you, not only as a Patron, but a Learned and proper Judge, submitting itself to such Censure as your worthy Self shall please to pass; and imploring your Pardon for this Presumption, the Author subscribes himself,

Honoured Sir,

Your most Devoted,

Faithful,

and Humble Servant

R. B.

Courteous Reader,

HAving for some Years past, frequently convers'd with divers Ingenious and Knowing Persons, in many Parts of the Mathematicks, some of them also being well affected to the Genethlical Part of Astrology: And although they well understand the Use of Trigonometry, for the Investigation of all the Requisites in a Nativity, yet thought the Opperation thereof by the Tables somewhat Tedious and Laborious, therefore were often wishing & bespeaking each other to spend some thoughts in order to propose such an instrumental Way, as might readily, and to a good measure of exactness, perform the same: But nothing for a long time being done herein, I did, at the Importunity of some of Them, diligently seek out and consider all such Projections that I could meet with, that hath any aptness for this Design, and at last fixed upon that Projection of Mr. John Stofferlin in his Astrolabe; which being projected on the Pole of the World, I thought would most naturally Represent, and that also by it might be most exactly measured the things hereafter apply'd to it. Two things I greatly desired herein; First, That in the various and multiplied

tiplied Lines that are upon the Instrument, they might be so projected, as to avoid Confusion, and be plain practical and ready in all the Uses thereof, that the meanest Capacity, (such as my self,) might easily understand and apply them. Secondly, *That the Instrument might be as independent as possible on any other Helps, that the Practitioner thereby should be readily furnish'd with such Prælimi-nary Requisites as are appendant to, and must be known for, the Calculation of a Nativity, as the Day of the Month, Suns Place, Declination, Right Assension,* &c. *all which are very exactly obtained by it. The truth is, the Use of the Instrument, as now 'tis made, hath increased upon my Hands beyond my first Intentions; for when I observ'd some vacant Places upon it, that might well be filled up with such Lines, that, by the help of the other, would delightfully perform not only the Astronomical Part of Astrology, but all other useful Conclusions of the Sphere, I was unwilling to let it go into the World without them: And therefore I have added the Artificial Numbers, Sines, Tangents, and Versed Sines, in four Circles, to be used by the Leggs of a Sector fastned on the Centre, or by Compasses, whereby you may not only try (if you please) the issue of the Question from the Projection, but may also, in all Latitudes, resolve any*

Question

Question that may be proposed to you: And although many Persons have not that kindness for the Judicial Part of Astrology, as that celebrated Science seems to call for, yet I hope no Mathematician or Ingenous Person will be afraid of being hurt, by knowing the Astronomical Grounds of it, or reject such an Instrument, as will not only help therein, but, in manifold, other Astronomical and Mathematical Uses. In the Second Part, I have added several Schemes, wherein the several Circles, which constitute the Triangles that do contain the Propositions of the First Part, are particularly Represented to the Eye; and have also granted upon the Ground and Reason of the Resolution of those and all other Triangles by the Artificial Lines, or by the Tables; whereby the Reader may the better conceive the Reason of, or, if he please, (with a little pains) may himself Form such Proportions as I have laid down for the Resolution of all the forementionʼd Propositions; and have also laid down many Astronomical Problems, that have no relation to Astrology; and shewed how to resolve them, both by the particular Line, called Hour and Azimuth, and also by the Artificial Sines and Tangents, as the Suns Rising, Setting, Length of the Day, Semi-diurnal Arch, &c.

As also how to find all the Requisites for any

Decli-

Declining Dial, and to Calculate all the Arches for the Hours Distances, and to prick them down upon the plain itself; and have also shewed how to take the Altitude of Sun, Moon, or Stars, as also the Altitude or Distance of any Place or Object, and readily to work out the Observation on the Artificial Lines; and have annexed a Catalogue of many of the Fixed Stars of the first and second Magnitude, with their Latitude, Longitude, Right Ascension, and Declination, whereby on the Instrument, the Hour of the Night may be exactly found with several other useful Conclusions. I hope the Reader will not think the worse of the Instrument, for the meanness of the Matter that is Directive of it; the truth is, I dislike That, I think, as much as any other can, only this I must say, that my Circumstances are such, that what I have written hath been with manifold Interruptions. A little now and then, as things did occur to my mind, whereby many things have been drawn out, and perhaps in some places repeated, that might have been spared; the whole, I know, might have been much more brief, coherent and dependant than it is; and yet, perhaps, my Inartificial plainness may, with some ordinary Readers, be more acceptable, than if it had been much better done: As it is, I heartily commend it to you, hoping, when you are well ac-

quainted

quainted with this Instrument, and its Uses, you will, at least, think I did what I could to give you Satisfaction therein; and am,

Your Real Well-wisher,

R. B.

ADVERTISEMENT.

THere are four Circular Lines, *viz.* Numbers, Sines, Tangents and Versed Sines, three of which are put on the Extream Limb of the Instrument, that were not intended when the first Part of the ensuing Book was written, which hath caused that Circle that was outermost then, to be the fourth from the Limb now; and therefore the Reader is desired, in his Reading of the first Part, to have no regard at all to the said four Circlar Lines, which are easily enough known by their Names proper to them. And whereas there is often mention made of a String and Bead put upon it, and sometimes of two Strings to be used in some of the Operations. Now instead thereof, and with much more exactness, we use two Strings affixed to the Legs, of

of a Sector, with Beads upon them, that perform all the Uses of the aforesaid Strings; only when you take the Altitude of the Sun or any other Object, you must take off the Legs of the Sector from the Centre of the Instrument, and hang a String and Plummet thereon, as is directed. There are also the Addition of the Days of the Month, under the Line of the Hour and Azimuth, whose Use you will meet with in Reading of the Second Part.

The Prints of the Instrument, which are seventeen Inches Diameter, are by themselves, or the same actually made up on Boards, to be had at the Publishers.

CHAP. I.

The Description of the Instrument.

THIS Instrument consists of Two Parts, *viz.* a Fore-side, and a Back-side; and First of the Back-side.

1. Upon the Limb of the Back-side is described three Circles, the outmost of which is divided into 365 divisions, representing the 365 days of the Common year, those again are divided into every 10 days with a little stroke thus —; likewise at the beginning of each Month is drawn a long stroke thus ———; without this Circle are placed the Names of each Month, with Figures set to every tenth day, as thus, *January* 10 20 31, *February* 10 20 28, *March* 10 20 31, and so of the rest. Moreover every seventh day is marked with a Cross thus +, they being numbred from the First day of *January*, for the more ready finding of the day of the Month.

2. Within the Circle of Months, is a Circle of Hours divided into 24 equal parts, representing the 24 Hours of the Day and Night, each of which is again sub-divided; first, into two parts, representing half hours, or thirty minutes of Time; secondly, each half hour is divided into fifteen parts, each containing two minutes of Time: These Hours are numbred from the tenth of *March* with Capital Figures, as I, II, III, IIII, V,

and ſo to XXIIII; the half Hours are deſtinguiſh-ed with a *Flower de Luce* thus ⚜, and every tenth Minute with a ſtroke thus I

3. Within this Circle of Hours, (and joyning to it) is a Circle of 360 deg. every of which is ſub-divided into ſix parts, each part containing ten minutes. Theſe degrees are numbred from the tenth of *March*, with 10 20 30 40, and ſo round to 360. This Circle ſerves to find the right Aſſenſion of the Sun or Stars.

4. Within theſe Circles is drawn a part of the Projection of the Sphere, deſcribed upon the Pole of the World, the Centre whereof (re-preſenting the North Pole) are deſcribed three Concentrick Circles, whereof that next the Centre is the Tropick of Cancer, the middle Circle is the Æquinoctial, and the other the Tropick of Capricorn.

5. Upon this Projection, and through the Centre (or Pole) are drawn two right Lines, cutting each other at right Angles, the one repre-ſenting the Equinoctial Colure, and meeting (upon the Limb) the one end with 360, the other end with 180 *deg.* the other Line repreſenting the Solſtical Colure, and meeting alſo upon the Limb; the one end with 90°, the other with 270 *deg.* and this part, or Semi-diameter of the Solſtical Colure, (whoſe Extream points to 270 upon the Limb) is divided into degrees, and (from the Equinoctial to 30 *deg.* towards the Pole) each of thoſe degrees is again ſub-divided into two parts, each 30 minutes; and from the Fore-ſaid 30 *deg.* to 90 at the Pole, the deviſion is only to every ſingle degree: So alſo from the Æquinoctial to the Limb, every degree is ſub-divided

divided into two parts, consisting each of 30 *min.* This Semi-diameter is numbred from the Æquinoctial towards Pole with 10 20 30, and so to 90 at the Pole, and so likewise from the Æquinoctial towards the Limb, with 10 20, and so to 29 *deg.* at the Limb.

6 Further, upon this Projection are described eleven Circles, all from different Centres, and cutting the Æquinoctial and Tropicks at oblique Angles, the middlemost of which is drawn somewhat fuller than the rest, and cuts the Æquinoctial in the two opposite points, *viz.* where the Æquinoctial intersects its proper Colure. This Circle, representing the Ecliptick, is divided into 360 parts or degrees, and each degree again into 2 equal parts, or 30 minutes, the other ten Circles are the parallels of Latitude of the Planets or Stars, *i. e.* the 5 within the Ecliptick are parallels of 5 *deg.* of North Latitude; and the 5 without the Ecliptick 5 *deg.* of South Latitude; the space between each Circle being only 1 *deg.* as you may see by the divided Semi-diameter. There are also Arches of great Circles crossing the Circles of Latitude at right Angles, and extended no farther than the two Extream Circles of Latitude: Those Arches are drawn through every degree of the Ecliptick, whereof (for distinction sake) each fifth is prick'd with small pricks, each tenth is described somewhat larger than the rest, and every thirtieth, or the beginning of each Sine, drawn fuller than the tenths. Within these Parallels of Latitude in their places and order, are the Names and Characters of the 12 Signs of the Zodiack, each Sign being figured at every tenth *deg.* and their numeration beginning

where the Ecliptick and Æquinoctial interſect each other at *Aries*, thus 10 20 30 ♈; *Taurus*, 10 20 30 ♉, and ſo of the reſt in order.

7. Towards the Limb of the firſt Quadrant, there is a line drawn from 21° 30′ of the Limb, through the plain of the Quadrant, making an Angle of 60° 00′ with the Solſtical Colure; this line is divided into 130°, which is called the Azamoth line, and likewiſe into eight Hours and a half, and is numbred from the Limb towards the Right hand, with 10 20 30, and ſo to 130°, (above the line, and (under the line) with I II III, and ſo to 8 hours, and back again with ſmaller Figures, as 4 5 6, and ſo to XII hours, the former ſhewing the Afternoon hours, and the later the Morning hours. Likewiſe on the plain of the ſecond Quadrant is drawn another line, and divided into 90 deg. and numbred from the Left hand towards the Right with 10 20 30, and ſo to 90; this is a line of Sines, by help of which, and the other line, is found the Hour and Azamoth for any time of the day exactly.

8. Laſtly, to this Back-ſide are fixed two Sights, *viz.* one at the divided Semi-diameter, or without the Circle of Months, between the tenth and eleventh day of *December*; the other, at the other end of the ſame line: Theſe Sights, with a Thred and Plumet hung upon the Centre, ſerve for taking Altitudes of the Sun and Stars.

II. *Of*

II. *Of the Fore-ſide of the Inſtrument.*

THE Fore-ſide of the Inſtrument conſiſts of Three Parts, *viz.* one Fix'd, and two Movable.

1. The fixed part is only the ſame as the Limb of the Back-ſide, the extream Circle being a Circle of Months, the next within that, a Circle of 24 Hours, the third a Circle of 360 degrees, all divided and numbred in each reſpect as thoſe on the Back-ſide, and therefore need no farther explanation.

2. Upon the fixed part moves a part of the ſame Projection as that on the Back-ſide, upon the Centre whereof (repreſenting the North Pole) are deſcribed three Concentrick Circles, *viz.* the Æquinoctial, and two Tropicks; the Æquinoctial is divided into 360 *deg.* and is numbred with 4 Quadrants, of 90 *deg.* each, as the common way is.

3. Through the Centre, and likewiſe through 90, and 90 in the Æquinoctial, is drawn a ſtreight line, repreſenting the Meridian, the one half of which is divided, and ſub-divided in all reſpects as was the divided half of the Solſtical Colure, in the Back-ſide; therefore this alſo needs no farther explanation.

4. The Horizon is drawn obliquely, interſecting the Æquinoctial on both ſides at no degrees, and the Meridian at a Point, diſtant from the Pole (or Centre, equal to the Latitude of the place 51° 32′, and is divided into *deg.* and *min.* and numbred from the Æquinoctial towards the Limb, with 10 20, *&c.* and from the Æquinoctial

ctial towards the Meridian, with 10 20 30, &c. on both sides the Meridian.

5. Through the intersection of the Horizon and Meridian are drawn Arches of Circles through every degree of the Æquinoctial, till they meet with the Limb; these are Circles of Position, whereof every thirtieth is described larger than the rest, representing the 12 Cœlestial Houses in Astrology, which are numbred with Capital Figures; the East Part of the Horizon assimulates the Ascendant or first House, and upon it is set the figure I: The North Part of the Meridian represents the fourth House, and is numbred with the figure IIII: The West Part of the Horizon describes the Descendant, or seventh House, and on it is set the figure VII: And the South Part of the Meridian (which is divided) represents the Mid-Heaven, or tenth House, and to it is adjoyned the figure X, so have you the four Angles. The other Intermediate Houses are figured in their order, with their respective Figures. Furthermore, every tenth Circle of Position (for its more easie distinguishment from others) is blacker than the rest, and every fifth is prick'd with small pricks; so that it will be very easie to find any Circle of Position desired.

6. The Limb of this Projection, or moveable, is divided into 360 *deg.* and numbred contrary to the Æquinoctial, for as the Æquinoctial is numbred from the East and West Points of the Horizon, with 10 20 30, and so to 90 at the Meridian; so the Limb is numbred with small Figures, from each Meridian, or the North and South Angles, towards the East and West, with 10 20 30, and so to 90. Every one of these

degrees

degrees is again ſub-divided into four Parts, each containing 15 *min*. This Circle is alſo numbred with Hours, beginning at the divided Meridian, and proceeding towards the Weſt with Capital Figures, as I II III, and ſo round, by XII at the North Angle to the South Angle or Meridian again, where the figure XXIIII ſhould have been placed, but (to avoid confuſion) is omitted. Of theſe Hours each is divided into two equal Parts, with a *Flower de Luce* to indicate the half Hours, each *deg*. contains 4 *min*. by its diviſion; ſo that any Minute part of an Hour may be found moſt eaſily and exactly.

III. *Of the Upper Moveable.*

1. THis Moveable is only a Circle (repreſenting the Ecliptick) divided into 360 unequal degrees, and numbred in all reſpects as the Ecliptick on the Back-ſide, beginning from the firſt Point of Aries, as 10 20 30 ♈; Taurus, 10 20 30 ♉, and ſo of the reſt in their order.

2. Upon the plain of the Ecliptick is deſcribed a little ſquare *Tabula*, or an Almanack conſiſting of 7 Columns, in the heads of which are inſerted the Names of the Days of the Week, and in each little ſquare is placed the Leap Years, the uppermoſt Row of theſe contains the Leap-Years from 1572 to 1600. As for Example, The Year 1572 is inſerted at length, and the next Leap-Year is 1576, of which you have only the two laſt Figures, 76, in the firſt ſquare, under *Monday*; the

the next succeeding number, to 76, in the same row, is 80, which shews the next Leap-Year to be 1580, and so of the rest, till you come to 1600 set down at length in the second row of Squares, and so every Leap-Year, from 1600 to 1700, having only the two last Figures inserted.

3. Note, that All the Leap-Years in that row of Squares where you find placed 1700, belong to 1600, but the numbers in all the rows below that, belong (and must be added) to 1700; so you see the greatest number above 1700, is 92, and the highest above 1600, is 72, whereby you have the Leap-Years for 106 Years to come, and 114 Years past.

4. In the middle of this *Tabula* are seven Letters of the Alphabet, *viz*. G F E D C B A, which are the Dominical Letters, *&c.*

CHAP.

CAAP. II.

The Use of the Instrument.

THE particulars of this Instrument being first well understood by the foregoing Description, we now come to demonstrate its various Uses, by which may be performed (with speed, ease and exactness) all those Propositions mentioned in the Catalogue; to proceed then, it will be necessary in the first place to know the Day of the Month in any year given, in order to which we shall first shew,

Prob. 1.

To find the Dominical Letter for any Time, past, present, or to come.

IF your Year be Leap-Year, you will find it amongst the little Squares in the square *Tabula* on the upper moveable, and under or over that Year you have the Dominical Letter from the 24*th*. day of *February*, till the *New-Years-Day* ensuing; but the letter next before it, is the Dominical Letter from the foresaid 24*th*. of *February*, backward to the 1*st*. of *January* preceeding. Thus every Leap-Year hath two Dominical Letters.

But if the Year be not Leap-Year, consider

 whether

whether it be the firſt, ſecond or third after Leap-Year, and having found the Leap-year preceding in the *Tabula*, count ſo many ſquares therefrom towards your Right Hand, and over or under that Square where your number ends, is the Dominical Letter for all that Year.

Example.

Let it be required to find the Dominical Letter for the Year 1688; I inſpect the Squares between the years 1600 and 1700, & find in the firſt Column, and ſixth row of Squares, 88, which tells me that the Year is Leap-Year; and over that I look to the row of Dominical Letters, and find G to be the Dominical Letter, from the Twenty fourth of *February*, to the Years end, and A, the next preceding Letter, ſhall be the Dominical from the Firſt of *January*, to the Twenty fourth of *February* that Year.

Again, ſhould it be required to find the Dominical Letter for the Year 1758, I look into the *Tabula* in the Squares under 1700, but not finding 58 there, I ſeek the neareſt leſſer number, which is 56, ſo I conclude that the Year 1758 is the ſecond after *Biſſextile* or Leap-Years, wherefore I caſt my eye upon the ſecond Square from 56 in the ſame row, over which I find the letter D, which is the Dominical Letter for all that year; and thus you may do for any other year within the limits of the *Tabula*, which comprehends 114 years paſt, and 106 to come.

Prob. 2.

Having the Dominical Letter given, to find what Day of the Week is the First of January.

ENter the ſquare *Tabula* with the Dominical Letter, and over it in the head of the ſame Column, you have the Day of the Week.

Example.

Let it be required what Day of the Week the Firſt of *January* begins in the year 1688, the Dominical Letter was found to be G, and over G, in the head of the ſame Column, I find *Mu.* which tells me that the Firſt of *January* that year will be upon a *Munday.* So in the year 1758, the Dominical Letter being D, the Firſt Day of *January* will be on a Thurſday, and ſo of any other.

Prob. 3.

The Week Day being given, upon which New-years-day *fell, in any Year, to find what Day of a Week any Day of a Month falls on throughout that Year.*

TO resolve this Proposition, have recourse to the circle of months on the Limb of the Backside, or the fixed part of the Fore-side, which is all one, where you shall find a little Cross on the First day of *January*, and likewise upon every seventh day throughout the Circle of Months; so that upon whatsoever day of any month any of those Crosses fall, that day must be the same day of the week, as was the First of *January* that year.

Example 1.

Be it required to find what day of the week the Fifth of *March* falls on, in the Year 1688; having first found that *New-Years-Day* (that year) is *Thursday*, I look to the Fifth of *March*, and find thereon a Cross, which shews that day to be *Thursday* likewise.

So the Tenth day of *August* in the same year, will be a *Munday*, because the sixth day preceding (having a Cross on it) is *Thursday*.

Again, the Eighteenth of *October* shall fall upon *Sunday*, the fifteenth day being Crossed, *&c.*

But

But if it ſhall be required to find the day of the month, knowing what week-day was the Firſt of *January* that year; this Propoſition will be reſolved by reverſing the laſt Rule.

Example 2.

Admit I would know what day of the month *Saturday*, about the middle of *April*, falls on, the Firſt of *January* (that year) being *Thurſday*, I look into *April*, and find therein five Croſſes, or *Thurſdays*, *viz.* the ſecond, ninth, ſixteenth, twenty fourth, and thirtieth, ſo (concluding my day muſt be between the ſixteenth, and twenty third) I count from the ſixteenth, which is *Thurſday*, and ſay, *Friday* 17, *Saturday* 18; thus I find my *Saturday* to be the eighteenth day of the month. I will urge one more.

Example 3.

A Perſon Born, *Anno.* 1652, on a *Sunday*, about the midſt of *May*, I deſire the day of the month.

Firſt I find by the foregoing Rules that the Firſt of *January* was *Friday*, then I ſeek *May*, and find the ſeventh and fourteenth days Croſſed, wherefore I count on from the fourteenth thus, *Friday* 14, *Saturday* 15, *Sunday* 16, the day required. Many other Propoſitions of theſe and the like kind, may be performed by the Square *Tabula* and *Calender*, or Circle of Months, but theſe I think ſufficient grounds for the finding any other of this nature.

Prob. 4.

Prob. 4.

The Day of the Month being given, to find the Suns Place in the Ecliptick.

THE Suns place or Longitude, is an Arch of the Ecliptick, contained between the first point of ♈, and that point of the Ecliptick which the Sun possesseth, according to the succession of the Sines.

This Proposition, and those which follow, are to be wrought by the Back-side.

Lay the Thred which moves upon the Centre, upon the day of the month, and whatsoever point of the Ecliptick it then cuts, is the day of the month.

Example.

Be the Suns place required for the twenty sixth day of *May*, I lay the Thred upon that day, and find it to cut the Ecliptick at 15° 00′ of *Gemini*, ♊, which is the Suns place required.

So on the Fifth day of *November*, the Suns place will be found to be 23° 35′ of *Scopio* ♏, and so of any other day of the year.

Prob. 5.

Prob. 5.

The Suns Place being given, to find the Day of the Month.

THis Propoſition is only the laſt reverſt, and its ſolution according, for if you lay the Thred upon the Suns place in the Ecliptick, at the ſame time it will fall on the day of the month.

Example.

I require the Day of the Month, the Sun being in 15° 00′ of *Gemini* ♊.

Lay the Thred upon 15° 00′ of *Gemini* ♊ in the Ecliptick, and it will likewiſe be extended upon the Twenty ſixth day of *May*, and ſo of any other.

Prob. 6.

The Suns Place in the Ecliptick given, to find his Declination.

THE declination of the Sun or Stars, is an Arch of a Meridian, which paſſes through the Centre of the Sun or Star, contained between the Æquinoctial, & the Centre of the Sun or Star.

First

First seek the Suns place, and lay the Thred thereat, moving the Bead up or down the Thred, till it touch upon the Ecliptick, then bring the Thred to the divided Semi-diameter, and the Bead will lye upon the declination sought.

Note, That if the Bead lies within the Æquinoctial towards the Centre, or North Pole, the declination is North; but if it lies without the Æquinoctial, it is South.

Example.

The Suns Longitude being 15° 00′ of *Gemini* ♊, we require his declination.

First lay the Thred on the Suns place, and bring the Bead exactly to touch therewith; then carry the Thred till it lye on the divided Semi-diameter; and the Bead will rest upon 22° 40′ North, from the Æquinoctial, which is the declination sought.

So the Sun being in 23° 45′ of *Scorpio*, his declination will be found to be 18° 43′ South.

Prob. 7.

The Declination of the Sun being given, to find his right Ascension, and also the Day of the Month.

LAY the Thred upon the divided Semi-diameter, and move the Bead till it rest upon the declination, North or South, then carry the Thred round, till the Bead cuts the Ecliptick, which it will

will do at two places (unless the Sun be in either of the Tropicks) but which of those places you require, you will easily know by the Season of the Year, and where the Bead lies in the Ecliptick, is the Suns place, and at the same time the Thred extended, will indicate the day of the month on the Limb.

Example.

Let the declination be 22° 43′ North, and the Suns place required; I lay the Thred on the divided Semi-diameter, and move the Bead till it rest on the declination 22° 43′ North, then I carry round the Thred till the Bead intersects the Ecliptick, which is in 15° 00′ of *Gemini* ♊, also at the same time the Thred will lie on the Twenty sixth day of *May*; but if I move the Thred further, the Bead will again intersect the Ecliptick at 15° 00′ of Cancer, and the Thred will lie on the Twenty sixth day of *June*, but which of those instants you look for, the time of the year will teach you.

So the Sun having 18° 43′ South declination, his place will be found to be 23° 45′ of *Scorpio* ♏, and the day & month the Fifth of *November*; or 6° 17′ of *Pisces*, and the day, the Third of *February*; and so of any other.

Prob. 8.

The Suns Place, or Day of the Month being given, to find his right Ascension.

THE right ascension of the Sun or Stars is an Arch of the Æquinoctial, contained between the first point of *Aries* ♈, and that Meridian which passes through the Centre of the Sun or Star, according to the succession of the Sines.

Fix the Thred on the day of the month, or on the Suns place in the Ecliptick, and where it cuts the Circle of 360° on the Limb, you have his right ascension in degrees and minutes; also where it cuts the Circle of 24 hours, you have his right ascension in hours and minutes of Time.

Example.

Let the day be the Twenty sixth day of *May*, or the Suns place 15° 00′ of *Gemini* ♊, at which the Suns right ascension is demanded.

Place the Thred on the Twenty sixth day of *May*, or on 15° 00′ of *Gemini* ♊, in the Ecliptick, and at the same time it shall cut upon 73° 43′, or 4^h 54′ of right Ascension.

So admit the Sun be in 23° 45′ of *Scorpio* ♏, his right ascension will be found to be 231° 11′, or 15 hours 24 minutes of Time.

Prob. 9.

Prob. 9.

The Suns right Ascension given, to find the Day of the Month, and his Place in the Ecliptick.

PLace the Thred upon the Suns right ascension and it will at once cut upon his place in the Ecliptick, and upon the day of the month; this is so plain and obvious, (being but the former Rule reverst) it needs no example.

Prob. 10.

The Day of the Month given, to find the Suns Place, right Ascension, and Declination, all at once.

LAY the Thred on the day of the month, and it will cut the Suns right ascension in degrees & minutes, and in hours and minutes; it will also decide its place in the Ecliptick, and if you move the Bead till it touches the Ecliptick, and then place the Thred upon the divided Semi-diater, the Bead will be upon the declination sought.

Example.

Suppose it required to find the Suns place, his right ascension and declination, on the Twenty sixth day of *May*; lay the Thred to the Twenty sixth of *May*, and the Bead thereon to the Ecliptick, so have you the Bead upon the Suns place 15° 00′ of *Gemini* ♊, and the Thred also cutting upon his right ascension 73° 43′ or 4 hours 53 minutes, then bringing the Thred upon the divided Meridian, the Bead will give you his declination also, which is 22° 43′ North.

So on *November* the Fifth, the Suns place will be found to be 23° 45′ of *Scorpio* ♏, his right ascension 231° 11′, or 15$^{h.}$ 24′, and his declination 18° 43′ South.

Note, What hath been said concerning the Sun, the same method is to be used in any of the Planets or Stars without Latitude.

We come now to demonstrate the Resolutions of all the propositions aforegoing, when the Planets or Stars have Latitude (either North or South) not exceeding 5 degrees.

Prob. II.

The Longitude and Latitude of a Star being given, to find his right Ascension and Declination.

THE Longitude of a Planet or Star, is an Arch of the Ecliptick contained between the first point of *Aries* ♈, and a Circle of Longitude passing through the Centre of the Star or Planet,

Planet, according to the succession of the Sines.

The Latitude of a Planet or Star, is an Arch of the Circle of Longitude, contained between the Ecliptick, and the Centre of the Star or Planet.

☞ Or thus, It is the distance between the Ecliptick, and the Centre of the Star, either North or South, as you find it explained in the Description of the Back-side.

So that if you lay the Thred over the intersection of the Circle of Longitude, with the Parallels of Latitude, it will cut the right ascension of that Planet or Star in the Limb, and if you move the Bead upon the Thred, till it lie upon the aforesaid intersection of the Circle of Longitude with the Parallels of Latitude, and then bring the Thred and Bead to the divided Semidiameter, and the Bead will shew the declination.

Example.

Suppose a Star or Planet in 2° 00′ of *Taurus* ♉, his Latitude 5° 00′ South; his right ascension and declination is required.

First lay the Thred on the intersection of 2° 00′ of *Tauaus* ♉, with 5° 00′ Latitude South, and thereto bring the Bead, then will the Thred cut upon 31° 34′, or 2 hou. 6 min. for the right ascension, then remove the Thred to the divided Semi-diameter, and the Bead will lie upon the declination, 7° 31′ North.

Again, Suppose a Planet or Star in 7° 00′ of *Gemini* ♊, with Latitude North 3° 00′, I desire to know the right ascension and declination.

Fix

Fix the Thred upon 7° 00′ ♊ with 3° 0′ North Latitude, so will it cut 62° 37′, or 4 hou. 10 min. the right ascension, and the declination will be found to be 24° 31′ North.

So if a Planet or Star be in 10° 00′ ♒, Latitude 4° 00′ South, the right ascension will be found to be 313° 37′, or 20 hou. 54 min. the declination 21° 39′ South; but admitting the Latitude were 4° 0′ North, the right ascension would be 311° 20′, and the declination 13° 55′ South, And so after this method for any other.

Prob. 12.

The right Ascension and Declination of a Star or Planet being given, to find his Longitude and Latitude

THis Proposition is only the last reverst, for if you lay the Thred upon the divided Semi-diameter, and move the Bead till it touch the declination given, and then remove the Thred to the right ascension given, the Bead will occupy both the Longitude and Latitude of the Planet or Star required; this is so plain, it needs no Example.

Prob. 13.

Prob. 13.

The Declination and Longitude of a Star, Planet, or Point given, to find his Latitude and right Ascension.

PLace the Thred upon the divided Meridian, and the Bead on the Declination given, then remove the Thred, so that the Bead may touch upon the Longitude given, and then the Bead will lie upon the Latitude sought, and the Thred upon the right Ascension on the Limb.

Example.

Let it be required to find the Lat. & right ascension of a Planet in 7° 0′ of *Gemini*, his Declination being 24° 31′ North, lay the Thred upon the divided Meridian, and move the Bead to 24° 31′ of North Declination, then move round the Thred till the Bead cut the seventh deg. of *Gemini* ♊, and at the same time it will lie upon 3° 0′ North Latitude, and the Thred upon the right Ascension (at the Limb) 62° 37′, or 4 hours 10 minutes.

Prob. 14.

Prob. 14.

The Latitude, and right Aſcenſion given, to find the Longitude and Declination.

LAy the Thred upon the given right aſcenſion, and let the Bead touch the given Latitude, & upon what Arch or Degree of Longitude, the Bead then lies, that ſhall be the Longitude required, then carry the Thred to the divided Semidiameter, and the Bead will alſo ſhew you the Declination ſought.

This being no more than the laſt Propoſition wrought Convers, will need no Example.

Prob. 15.

The Longitude, and right Aſcenſion given, to find the Latitude and Declination.

PLace the Thred upon the right Aſcenſion given, and move the Bead along the Thred, till it lies on the given Longitude, and it will ſhew you the Latitude among the Parallels of Latitude, then if you carry the Thred and Bead to the divided Meridian, the Bead will ſhew you the Declination.

Example.

Example.

A Star or Planet being in 2° 0′ ♉, and his right Aſcenſion 31° 34′, I require his Latitude and Declination.

Firſt I place the Thred upon the right Aſcenſion 31° 34′, then move the Bead till it touch the Longitude ♉, 2° 0′, then will the Bead alſo be on 5° 0′ of South Lat. then I carry the Thred and Bead to the Semi-diameter, and the Bead gives the Declination I required 7° 31′ North.

Prob. 16.

The Latitude and Declination of a Star or Point given, to find his Longitude and right Aſcenſion.

LAY the Thred on the divided Semi-diameter, and move the Bead to the given Declination, then carry the Thred about till the Bead lie on the given Latitude, and it will alſo reſt upon the degree of Longitude, and alſo the Thred ſo lying will cut the right Aſcenſion on the Limb. This is ſo plain, it needs no Example, being only the laſt reverſt.

Prob. 17.

How to observe the Altitudes of the Sun, or Stars.

THE Altitude of the Sun or Stars is an Arch of an Azimuth which is contained between the Horizon, and the Centre of the Sun or Star, or thus, is the nearmost distance of the Sun or Star to the Horizon.

The sights being fixed as was shewed in the Description, with a Thred and Plumet upon the Centre; take the Instrument in your two hands, hold it perpendicular, with your Left side towards the Sun, and hold it so as that the Sun-beams which passes through the Sight at your Left hand, which must be at the divided Semi-diameter, may also pass through the Sight at your Right hand, then at the same instant observe what degrees, *&c.* the Thred cuts at the Limb, for so many degrees is the Altitude of the Sun.

But to observe the Altitudes of the Stars, you must use another method, because the Rays or Beams of the Stars cannot be discerned through the Sights, wherefore if you hold up the Instrument (with that Sight which you held at your Right hand) to your eye, and look through both Sights till you can see the Star or Planet (whose height you seek) at the same time the Thred will cut the Altitude required, or else look by the upper edges of both Sights, and it will effect the same thing.

But

But if you would have the Meridian Altitude of the Sun or Stars, you must begin your Observation a little before the Sun or Star comes to the Meridian, and so continue till they be past, still minding the greatest Altitude, and when the Altitude decreaseth, you may know the Sun or Star Observed, is past the Meridian ; so the greatest Altitude is the Meridian Altitude.

Prob. 18.

The Meridian Altitude of the Sun or Star being given, to find their Declination.

IF the Meridian Altitude be more than the Complement of the Latitude, substract the Complement of the Latitude therefrom, and the remainder is the Declination, North.

But if the Complement of the Latitude exceed the Meridian Altitude, then substract this from that, and the Remainder is the Declination, South.

Example.

Suppose the Meridian Altitude to be 46 deg. and the Complement of the Latitude 38° 28′, the Declination is hence required ; here finding the Meridian Altitude greater than the Complement of Latitude, I substract 38° 28′ from 46° 00′, and find the remains 7° 32′, the declination North equired.

Again, Let the Meridian Altitude be 16° 49′, and the Complement of the Latitude, as before, the Meridian Altitude being less than the Complement of the Latitude, I substract it therefrom, and find the remains 21° 39′, the Declination, South; and so of any other.

Prob. 19.

The Declination and Altitude of the Sun being given, to find the Hour of the Day.

TO Resolve this Question, you must have a pair of Compasses, and setting one Point of the same on the beginning of the line of Sines, and extend the other to the given Altitude, then lay the Thred from the Centre, over the Declination given (it being numbred from 60 deg. on the Limb) then set one point of your Compasses on the line of Hours, , *viz.* in the lowermost divided line, between the Thred and the beginning of the line, at XII, and move it nearer or further, to, or from the Thred, till by turning the other point about it may just touch the Thred, and the other point shall rest on the true hour of the day; if you be in doubt whether it is the Forenoon or Afternoon, it may easily be determined by another Observation, that is, if the Altitude increase, it is the Forenoon; but if it decrease, the contrary.

Note,

Note, The Limb is numbred from 60 deg. on both sides, with small Figures, as 10, 20, 30, and so on. Note likewise, That if the Declination be North, then you must lay the Thred on the Declination, numbred from 60°, or no deg. of the small Figures, towards the Right hand; but if the Declination be South, it must be laid from 00 deg. or 60, towards the Left hand, &c.

Example 1.

The Tenth day of *May* the Declination of the Sun, is 20° 14′, North, and observing the Suns Altitude, I find it to be 30 deg. I would know the hour of the day.

I set one point of my Compasses on the beginning of the line of Sines, and extend the other to 30 deg. of the same, the Altitude found; then I lay the Thred on 20° 14′, the Declination, it being numbred towards the Right hand, because the Declination is North, then I set one point of my Compasses on the line of Hours, between the Thred and the beginning of the line, at XII, and by moving it nearer or further, till (by turning the other point about) it just touch the Thred, and the fixed point gives me the Hour, which I find to be 32 min. after seven in the Morning, or 28 min after four in the Afternoon.

Example 2.

November the Twenty fifth, the Declination of the Sun, is 22° 30′, South, and observing the Altitude,

Altitude, I find it to be 10 deg. therefore I take 10 deg. of the line of Sines between my Compasses, and laying the Thred on 22° 30′ on the Left side of 00 deg. or 60, because the Declination is South, then setting one point of the Compasses on the Left side of the Thred, and by moving them about, as before, till the other point touch the Thred, I find the fixed point to stay at 20 min. before X in the Morning, or 20 min. after II in the Afternoon, and such are the hours, the Altitude being 10 degrees.

Prob. 20.

The Altitude and Declination of the Sun being given, to find the Azimuth.

THE Azimuth is an Arch of the Horizon, contained between the North or South Points thereof, and a line drawn from the Zenith through the Centre of the Sun or Star, till it meet with the Horizon, cutting the same at right Angles.

To find which, take the Declination out of the line of Sines between your Compasses, and lay the Thred on the Altitude, counted from 60 deg. or no degrees of the small figures, then set one point of your Compasses on the Azimuth line on the right side of the Thred, if the declination be North, but on the left side if it be South declination and carrying the Compasses along the Azimuth line till by turning the other point about

about it may juſt touch the thred and the fixed point ſhall ſtay at the true Azimuth required.

Example 2.

Let the Declination be 10° 00′, North, and the Altitude 20° 00′ the Azimuth from the South is required. Set one point of your Compaſſes on the beginning of the line of Sines, and and extend the other to 10 deg. the Declination, and lay the Thred on 20 deg. counted from 60, on the Left hand, then ſet one point of your Compaſſes on the Azimuth line, towards the Right ſide of the Thred, (becauſe the Declination is North) ſo carry the point of the Compaſſes along the line, till by turning the other point about, it may juſt touch the Thred, and the fixed point ſhews the Azimuth, which I find to be at 80° 42′ from the South; but if the Sun have no Declination, then if you lay the Thred on the given Altitude, the Thred will cut the Azimuth required.

Example 2.

Let the Declination be 10° 00′ South, and the Altitude 20° 00′, as before, take the Declination in your Compaſſes, as before, and the Thred laid to 20° 00′, the Altitude; then ſet the Compaſſes on the Azimuth line, on the Left ſide of the Thred, and by turning the Compaſſes about till it juſt touch the Thred, and you will find the fixed Point to ſtay at 41° 10′, the Azimuth from the South; and ſo of any other.

Prob. 21.

Prob. 21.

The Declination, right Ascension, and Altitude of a Star, with the right Ascension of the Sun being given, to find the Hour of the Night.

First observe the Altitude of any Star you desire to find the Hour of the Night by (as you have it in the Fifteenth *Problem*) then find his Declination by a *Tabula* of the Longitude and Latitude, right Ascension and Declination, which I have inserted at the end of the Book, for this and some other uses, then take the Altitude out of the line of Sines, as you was directed in finding the Hour by the Sun, you shall find how much the Star wants, or is past the Meridian, which is called the Stars hour.

Note, If the Star be past the South, it is in the Afternoon; but if it wants of coming to the South it is in the Morning; this being done, you must have recourse to the Hour Circle upon the Limb; as thus, set one point of the Compasses on the hours and minutes of the Suns right Ascension, and extend the other point to the hours and minutes of the Stars right Ascension, noting which way you turn the Compasses; that extent being laid the same way from the Stars hour last found, the other point shall shew the true Hour of the Night.

Example.

Example 1.

Suppose on the Twelfth day of *August*, I observe the Altitude of Arcturus to be 25 deg. then I look in the *Tabula* for Arcturus, and find his Declination to be 20° 54′, North; then I take 25 deg. (the Altitude) between the Compasses, and setting one point upon the Hour line (the Thred being laid to 20° 54′, the Declination) and by turning the other point about till it just touch the Thred, and the fixed point will stay at 5*h.* 4′ to the West of the Meridian, which is the Stars hour.

Then set one point of your Compasses on 1*h.* 8′ in the Hour Circle, upon the Limb, the Suns right Ascension, and extend the other to 14*h.* 1′, the right Ascension of Arcturus, that extent lay from 5*h.* 4′ (the Stars hour) the same way, the other point shall rest upon 8*h.* 57′, which is the true Hour of the Night.

Example 2.

Suppose on the Tenth day of *January*, I observe the Altitude of the Bulls Eye to be 20 deg. likewise I look in the *Tabula* for the Bulls Eye, and find his Declination to be 15° 48 North, and his right Ascension 4 hou. 16 min.

Then I take 20° 00′, the Altitude, from the line of Sines, as before, (the Thred being laid on 15° 48′ on the Limb, the Declination North; then set one point of your Compasses on the Azimuth line, taking the nearmost distance to the Thred, you will find the fixed point to stay

at 6 hou. 49 min on the East side of the Meridian.

Then finding the Suns right Ascension for that day to be 8 hou. 12 min. then set one point of your Compasses to 8 hou. 12 min. (on the Hour Circle, on the Limb) the Suns right Ascension; and extend the other point to 4 hou. 16 min. the Stars right Ascension, the same extent shall reach the same way from 6 hou. 49 min. the Stars hour, to 2 hou. 53 min. the true Hour in the Morning.

Prob. 22.

Having the Altitude and Declination of a Star given, to find the Azimuth, or the point of the Compass the Star is upon.

THis is the same as for the Azimuth of the Sun, thus.

Lay the Thred on the Stars Altitude on the Limb, towards the Left hand of 60° 00′, then take the Declination from the line of Sines, and carry your Compasses on the Right side of the Thred, for North Declination; and on the Left, for South, along the Azimuth line, till the other point just touch the Thred, and the fixed point will stay at the Azimuth sought. This needs no Example, it being so plain by the Sun.

Many other Propositions might be performed by this Back-side. That is, if a Ruler and Sights be

fitted on the Centre, you may take Angles in a Field, or Hights and Distances; likewise the distance of two Stars, with many other such like; but supposing what hath been said, is sufficient for the understanding of any others.

I come in the next place, to shew what propositions may be resolved by the Fore-side.

CAAP. III.

The Uses of the Fore-side of the Instrument.

Prob. 1.

How to find the Suns Place, Right Ascension, and Declination.

BEfore you can resolve this Proposition, you must Rectifie the Ecliptick (or upper Movable) which is done thus. Bring the Thred which is fastned on the Centre, to 360° or the Tenth day of *March*, upon the Limb of the fixed part, then turn the Ecliptick, till the Semi-diameter (which divides *Pisces* and *Aries*) lie exactly under the Thred, and there keep it fast, so have you the Ecliptick rectified,

fied, and fitted for the resolution of these propositions.

First then, Lay the Thred upon the day of the month, and it will cut the place of the Sun in the Ecliptick, and likewise his right Ascension on the Limb of the fixed part, then move the Bead upon the Thred till it touch the Ecliptick, then carry Thred and Bead to the divided Semi-diameter, and the Bead will give you the Declination sought; these Propositions being before exemplified in the Uses of the Back-side, doth here need no Example.

Prob. 2.

The Declination of the Sun or Star being given, to find the Amplitude.

THE Amplitude of the Sun or Stars, is an Arch of the Horizon, contained between the East or West points thereof, and the point whereupon the Sun or Star rises or sets.

To find which, Lay the Thred on the divided Semi-diameter, and move the Bead to the Declination given, then carry the Thred about till the Bead rests upon the East part of the Horizon, then shall the Bead shew the Amplitude required.

Example 1.

Suppose the Sun to have 10° 32′ of Declination,

tion, I require his Amplitude. The Thred being laid on the Semi-diameter, and the Bead mov'd to 10° 32′ of North Declination; I remove the Thred and Bead till the Bead lies on the Horizon, which I find to do at 16° 53′, and such is the Amplitude, the Sun having 10° 32′ of Declination.

This Proposition is very useful in Navigation, for finding the variation of the Compass.

Prob. 3.

The Amplitude being given, to find the Declination.

PLace the Thred over the given Amplitude in the Horizon, and thereto bring the Bead, then move the Thred and Bead to the divided Semi-diameter, and where the Bead lies, you have the Declination. This needs no Example.

Prob. 4.

Prob. 4.

The Declination of the Sun or Stars given, to find their Ascensional Difference, or the Time of their Rising and Setting, together with the Length of the Day and Night.

THE Ascensional Difference is an Arch of the Æquinoctial, contained between the East or West points of the Horizon, and the Meridian passing through the Centre of the Sun or Star, at his rising or setting. Or thus:

☞ It is the difference between the right and oblique Ascension. To find which,

The Bead being rectified to the Declination, (as before) move along the Thred till the Bead touch the Horizon, on the East side thereof, which done, the Thred cuts the Equinoctial at the Ascensional difference desired.

It also cuts the Hour of the Suns rising (it being numbred from the North part of the Meridian, or fourth House, where XII is described at the Limb) calling XIII, I, and XIV, II, and so on till you come to the Thred.

Then if you move the Thred and Bead till the Bead touch the West side of the Horizon, the Thred will cut upon the Hour of the Sun or Stars setting.

And if you double the Suns setting, it gives you the length of the Day, and double his rising, is the length of the Night.

Example

Let it be required to find the Ascensional difference of the Sun, his Declination being 10° 32′, North. Rectifie the Bead to the Declination, (as is before shewed) that is 10° 32′ North, then move the Thred over the East part of the Horizon, till the Bead rest exactly thereon, and at the same time the Thred will cut the Æquinoctial at 13° 34′, which is the Ascensional difference required: The Circle of Hours will be also cut at 54 min. before VI (or if you number from the Midnight XII, you will find it to be V hou. and 6 min. after Midnight) at which time the Sun rises, when his Declination is 10° 42′ North, then if you double 5 hou. 6 min. it makes 10 hou. 12 min for the length of that Night.

Again, if you move the Thred round till the Bead touch the Western part of the Horizon, you shall find the Thred to lie upon 54 min. after VI, the time of the Suns setting, which also being doubled, is 13 hou. 48 min. the length of the Day.

To know the duration of a Star or Planet, above or beneath the Horizon, is the same with finding the length of the Day or Night.

Prob. 5.

Prob. 5.

The right Ascension and Ascensional difference being given, to find the oblique Ascension and Descension.

THE oblique Ascension is an Arch of the Æquinoctial, contained between the first point of *Aries*, and that point of the same, which rises with the Sun or Star.

☞ The oblique Descension is the same Arch, terminated by the setting of the Sun or Star.

But to resolve this Proposition. Lay the Thred upon the right Ascension, in the Limb of the fixed part, then turn the Movable about till the Ascensional difference (given) upon the Æquinoctial, lie under the Thred, then remove the Thred, and place it upon the East intersection of the Horizon and Æquinoctial, and then it will cut the oblique Ascension in the fixed Limb.

Then if you remove again the Thred, and place it upon the West intersection of the Æquinoctial with the Horizon, it will cut upon the oblique Descension at the Limb, as before.

Note, That if the Declination be North, the Thred must lie over the Ascensional difference in the North part of the Æquinoctial, or (which is plainer) that part thereof which is under the Horizon; but if the Declination be South, you must so order the Movable, thae the Ascensional difference (lying under the Thred) be

numberd

numbred on that part of the Æquinox which is above the Horizon.

Example.

Admit the right Aſcenſion be 132° 27′, the Aſcenſional difference 22° 55′, Declination North, and the oblique Aſcenſion required. Firſt place the Thred upon 132° 27′, the right Aſcenſion given, then move the Moveable till the Aſcenſional Difference, 29° 55′ (upon the Æquinoctial) lies right under the Thred, then move the Thred towards your Left hand, and place it upon the interſection of the Horizon and Æquinoctial, at the Eaſt, and it will divide the Limb at 102° 22′, which is the oblique Aſcenſion ſought.

For the oblique Deſcenſion (the Thred being on the right Aſcenſion, as before) bring the Deſcending part of the Horizon and Æquinoctial thereto, and join the aforeſaid Aſcenſional difference (29° 55′, under the Horizon) to the Thred, then remove the Thred upward till it touch the interſection of the Horizon & Æquinoctial, and then it will alſo cut upon 162° 22′, the required oblique Deſcenſion.

But this propoſition may be very eaſily ſolved by the Pen, thus ——

If the Declination is North, ſubſtract the Aſcenſional diference from the right Aſcenſion, and the Remainder is the oblique Aſcenſion; but if you add it to the right Aſcenſion, the Sum will be the oblique Deſcenſion.

If the Declination is South, add the Aſcenſional difference to the right Aſcenſion, and the Sum is the oblique Aſcenſion; but if you ſubſtract it, there reſts the oblique Deſcenſion.

CHAP. IV.

The Use of the Instrument in Astrology.

Prob. 1.

How to Erect a Figure of the Cœlestial Houses, for any time, past, present, or to come.

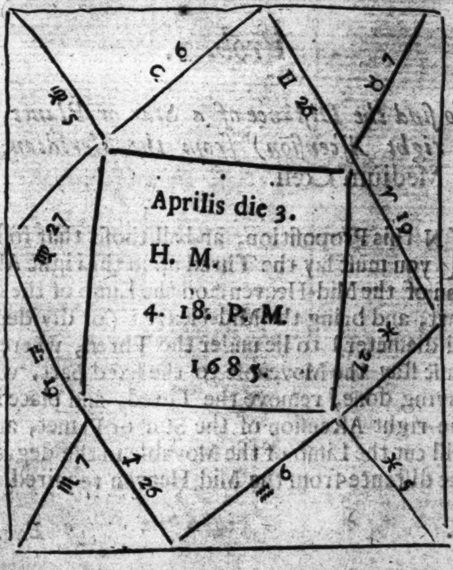
FIRST, Lay the Thred upon the Day of the Month, and it will cut the righ Ascension of the Sun (in hou. and min.) at Noon; then add thereto the (given) hou. and min. past Noon, and place the Thred upon the Sum, (in the movable Circle of Hours) then move the Ecliptick till the Semi-diameter (at the first point of *Aries*) lies right under the Thred, and there fix it, by screwing it fast on the Centre. Then look what Signes and Degrees of the Ecliptick, are cut by the 12 Circles of Position, which represent the 12 Houses, for those Signes and Degrees are the Cusps of the several Houses by them represented.

Example.

Let it be required how the Face of Heaven stands, the Third day of *April* at 4 hou. 18 min. past Meridiem, *Anno* 1685. First lay the Thred

upon

upon the Third day of *April*, in the Limb of the fixed part, and it will cut the Circle of Hours (next within that) at 1 hou. and 29 min. to which the 4 hou. 18 min. (the time from Noon given) being added, the Sum is 5 hou. 47 min. which 5 hou. 47 min. you must find upon the Moveable Hour-Circle, and place the Thred thereupon. Then the first point of *Aries* being rectified to the Thred, and the Centre fastned with the Screw, or other ways, you will find the divided Semi-diameter, or tenth House, to cut the Ecliptick at 26 deg. of ♊, the eleventh House at 6 deg. of ♌, twelfth at 5 deg. of ♍, and on the Ascendent, or first House ♍, 27 deg. and so of the rest in order, as you may see in the following Scheme.



Thus having Erected your Figure, and placed the Sines and Degrees on the Cusps of their proper Houses, you must take the Planets places out of an Ephemeris for that year, (or by Mr. *Street's* Planetery System) and place them in their respective Sines and Degrees in the Figure, which any one, but meanly-vears'd in Astrology, knows how to do.

I shall not here treat any thing of the Rudiments of Astrology, that being largely handled by many Authors, my design being only to explain the Uses of the Instrument, in the Genethliacal Part, for the easie and speedy performance of all Propositions thereto belonging.

Prob. 2.

To find the Distance of a Star or Planet (in right Ascension) from the Meridian, or Medium Cœli.

IN this Proposition, and all those that follow, you must lay the Thred upon the right Ascension of the Mid-Heaven, on the Limb of the fixed part, and bring the Mid-Heaven (or divided Semi-diameter) to lie under the Thred, where you must stay the Moveable to the fixed part, which having done, remove the Thred, and place it to the right Ascension of the Star or Planet, and it will cut the Limb of the Movable in the degree of the distance from the Mid-Heaven required.

Example.

Example.

Let the right Aſcenſion of the tenth Houſe, or *M. C.* be 86° 45′, or 5 hou. 47 min. as in the laſt Example, and admit a Star or Planet be in the eighth Houſe, whoſe right Aſcenſion ſhall be 23° 47′, we require his difference from the *M. C.*

Firſt, Place the Thred upon the right Aſcenſion of the *M. C.* 86° 45′, and thereto bring the tenth Houſe, or *M. C.* on the Moveable, then lay the Thred (to the Limb of the fixed part) upon 23° 47′, the Planets right Aſcenſion, and it alſo cuts upon the Limb of the Movable 62° 58′, which is the diſtance of the Planet, *&c.* from the tenth Houſe, or *M. C.* ſought.

Prob. 3.

The right Aſcenſion and Declination of a Planet or Star gives, to find what Circle of Poſition he is upon.

Circles of Poſition are great Circles of the Shpere, meeting or cutting each other in the North or South Point of the Horizon, and paſſing through the Centre of any Star or Planet, to find which,

Rectifie the Bead to the Declination, then place the Thred upon the right Aſcenſion of the Planet, in the Limb of the fixed part, (the tenth Houſe, or *M. C.* being ſet to the right Aſcenſion thereof) and the Bead ſhall lie upon the Circle of Poſition required.

Example.

Example.

Let it be required to find the Circle of Position of a Planet, having 23° 47′ of right Ascension, and 9° 42′ of North Declination, rectifie the Thred and Bead to the Declination given, 9° 42′ North. (the *M. C.* being first set to the right Ascension thereof, 86° 45′) then lay the Thred upon the Planets right Ascension, 23° 47′, and the Bead will lie on the seventh Circle from the Cusps of the eighth House, which is the Circle of Position sought.

Prob. 4.

The Circle of Position of any Star or Planet being found, to find the heigeth of the Pole above the same.

THE height of the Pole above a Circle of Position, is an Arch of a Meridian, contained between the Pole and Circle of Position, or the nearest distance of the Pole to that Circle, which to find,

Lay the Thred over the Circle, so as that it may cut it at right Angles, then move the Bead to the Circle, and (by moving the Thred to and fro, and the Bead up or down) gain the nearest distance to it, from the Pole or Centre; this done, carry the Thred and Bead to the divided

ded Meridian, and the Bead will lie on the height of the Pole above the Circle, it being numbred from the Pole, or Centre, at 90 deg. calling 80, 10, 70, 20, and ſo on to more or leſs.

Example 2.

Let the Circle of Poſition given, be the ſeventh Circle from the Cuſp of the eighth Houſe (as in the laſt) having gain'd the diſtance (between the Pole, and the neareſt part of the Circle thereto) with the Bead on the Thred, lay the Bead on the divided Semi-diameter, and it will touch upon the 45° 30′ numbred from the Pole, the Poles Elivation required. And ſo of any other.

Prob. 5.

The right Aſcenſion and Declination of a Planet being given, to find the Aſcenſional difference under his Circle of Poſition.

THE Aſcenſional difference of a Planet or Star, under his proper Circle of Poſition, is an Arch of the Æquinoctial, contained between the Circle of Poſition, and a Meridian paſſing through the Centre of the Star.

To find which, rectifie the Bead to the Declination given, then lay the Thred to the Limb, upon the given right Aſcenſion, & the Bead will lie on the Circle of Poſition of the Star or Planet, then

trace

trace with your eye that Circle, till it crosses the Æquinoctial, and the number of Degrees contained between that point and the Thred, is the Ascensional difference sought.

Example.

Admit the right Ascension of a Planet be 23 deg. 47 min. and his Declination 9 deg. 42 min North, rectifie the Bead to 9° 42′ North Declination, then place the Thred upon the right Ascension, 23° 47′ on the Limb of the fixed part, and the Bead will lie on the seventh Circle, from the Cusp of the eighth House, which Circle trace to the Æquinoctial, and from its intersection therewith to the Thred you will find the Arch 9° 7′, the Ascensional difference required of that Planet, under his proper Circle of Position.

Prob. 6.

To find the oblique Ascension or Descension of a Planet, &c. under his Pole of Position, right Ascension and Declination given.

THE oblique Ascension of a Planet under his proper Circle of Position, is an Arch of the Æquinoctial, contained between the Circle of Position, and the first point of *Aries*; the same is the oblique Descension, only whereas, in oblique

oblique Ascensions the Circles of Position, are in the Ascending part of Heaven, but in oblique Descensions in the Descending Part.

So if a Planet or Significator shall be located in any of the six Oriental Houses, as 10*th.* 11*th.* 12*th* Ascendant 2*d.* 3*d.* he is to be directed by oblique Ascension; but if in the Occidental Part, as 5*th.* 6*th.* 7*th.* 8*th.* 9*th.* or 10*th.* Houses, he must be directed by oblique Descension.

First then, rectifie the Bead (as before) to the given Declination, next lay the Thred upon the right Ascension on the Limb, and the Bead will lie on the Circle of Position, which being traced to the Æquinoctial, and the Thred placed on the intersection, will cut the oblique Ascension or Descension on the Limb of the fixed part.

Or thus, without having regard to the right Ascensions or Declinations, knowing the Circle of Position, you may lay the Thred on the intersection thereof with the Æquinoctial, and it will cut upon the oblique Ascension or Descension as before.

Example.

Admit a Planet in the eighth House with 23° 47′ of right Ascension, and 9° 42′ Declination *North* (as before) his oblique Descension is required; first rectifie the Bead to the Declination 9° 42′ *North*, then the Thred upon the right Ascension 23° 47′ will cut (at the Bead) the seventh Circle from the Cusp of the eighth House, which Circle trace to the Æquinoctial, and upon the intersection, the Thred being placed, will

cut the Limb of the fixed Part, at 32° 54′ the oblique Descension sought.

Again, Suppose a Planet in the second House, with 206° 19′ of right Ascension, and the Declination 10° 8′ *South*, the oblique Ascension is required, rectifie the Bead to 10° 8′ *South* Declination, then lay the Thred on 206° 19′ the right Ascension, the Bead will lie on the seventh Circle from the Cusp of the second, then trace the Circle till it meet with the Æquinoctial, and thereto lay the Thred, and it will cut the Limb of the fixed part in 215° 49′ the oblique *Descension*.

Prob. 7.

To find the Ascensional Difference of a Promittor under the Significators Circle of Position, the Declination being Given.

BY a Significator is generally meant some one of the Hylegicals, *viz.* the Ascendant Mid-Heaven Sun, Moon and Part of Fortune; and sometimes the other Planets are accepted as Significators

☞ By Promittor is meant any Planet, Star, or Aspect directed to.

☞ The Ascensional Difference of a Promittor under his Significators Circle of Position, is an Arch of the Æquator contained between the aforesaid Circle of the Position and a Meridian, passing through the Center of the Promit-

tor,

tor, being come to the Circle of Position of the Significator: which to find,

Rectifie the Bead to the Declination, then move the Bead and Thred, till the Bead touch the Significators Circle of Position, and the Degrees upon the Æquinoctial contained between the Thred and the Circle of Position, is the Ascensional Difference sought: How to find the Circles of Position of the Significator is already shewed in the third Proposition of this Chapter.

Example.

Suppose a Promittor have 46° 00′ of right Ascension, and his Declination be 5° 00′ *South*, I will require the Ascensional Difference under the Circle of Position of a Significator, being posited in the eighth House, his Circle being found to be the seventh from the Cusp of the eighth House.

First, Then rectifie the Bead to the Declination of the Promittor 5° 00′ *South*, then carry the Thred round till the Bead touch the seventh Circle from Cusp of the eighth House, then trace the Circle to its intersection with the Æquinoctial, and you will find an Arch of 5° 3′ contained between the Circle and the Thred, which is the Ascensional Difference sought.

Prob. 8.

The right Ascension and Declination of a Promittor given, to find his oblique Ascension, under the Significators Circle of Position.

THis Proposition is found by Adding or Substracting the Ascensional Difference, to or from the right Ascension, as you were shewed in the fifth Proposition of the third Chapter.

Example.

Let the Significators Circle of Position be the seventh from the Cusp of the eighth House, (as before,) the right Ascension of the Promittor 46° 00′ and the Declination *South* 5° 00′ I require the oblique Ascension in the foresaid Circle of Position, which is thus found.

First find the Ascensional Difference as in the last Proposition which was found to be 5° 3′; which Substract from the right Ascension, 46° 00′ the Remains are 40° 57′ the oblique Ascension desired, and so of the rest.

Prob. 9.

Prob. 9.

To find the Arch of Direction.

THE Arck or Arch of Direction in an Arch of the Æquinoctial, contained between the right Ascention of the Promittor, and a Meridian which passeth through the Centre of the Promittor, when (by the Motion of the Earth) he comes to touch the Significator's Circle of Position; to find which,

Substract the oblique Ascension or Descension of the Significator, from the oblique Ascension or Descension of the Promittor, and the Remainder is the Arch of Direction.

Example.

The Oblique	of a Significator being	32	54
	of a Promittor	40	57
	The Arch of Direction is	8	3

Prob.

Prob. 10.

To find the Arch of Direction, without having Respect to the oblique Ascension or Descension of the Significator or Promittor.

First find the Circle of Position of the Significator, by the third Proposition of this Chapter, then Rectifie the Bead to the Declination of the Promittor, and move the Thred about, till the Bead touch the Circle of Position of the Significator; then if you lay a Thred on the right Ascension of the Promittor, the Arch contained between the two Threds is the Arch of Direction.

Example.

Admit the Circle of Position of the Significator, be the seventh Circle from the Cusp of the eighth House, the right Ascension of the Promittor 46° 00′ and the Declination 5° 00′ *South*, I require the Arch of Direction, which I find thus; First I rectifie the Bead to the Declination 5° 00′ *South*, then I move the Thred about till the Bead touch the foresaid Circle of Position, at which time, the Limb of the fixed Part is cut by the Thred at 37° 57′ which I Substract from

from the right Ascension of the Promittor 46° 00′ and find the Remainder 8° 3° which is the Arch of the Direction *South*, as before.

Prob. II.

How to Rectifie a Nativity.

THe Rectefication of a Nativity, is to find the true time of Birth, from the supposed time; which is best done by the Natives Accidents Past.

To perform this (your Scheem being Erected to the Estimate Time) and the true places of the Planets inscribed therein, you must endeavour to attribute the most notable Accidents given to their proper Directions, either by conceiving the Direction by Inspection of the Figure, or by Drawing an Estimate Speculum thus,

Take a Quarto Page of Paper, and devide the bredth into 13 Collumns, and the length into 31 Collumns; then in the first Collumn towards the left hand, set the Degrees of the Signes in their order, Descending from a Cipher at the top, down to 30 at the bottom, then in the heads of the other 12 Collumns in bredth, inscribe the 12 Sines, beginning with ♈ ♉ ♊ and so to ♓ in the last Collumn, then set each Planet in the Collumn of his respective Signe, and right against his Degree in the Collumn at the

Left Hand, as also his Aspect in the Signes they fall in; this done, you must also place the Ascendant, noted with Asc. and the Mid-heaven, noted with *M. C.* in their respective Signes and Degrees, and if you please, also, the Cusps of the other Houses, with ☊ ☋, and part of *Fortune*.

This done, and the Direction pitcht upon, by which (especially) you would Rectifie the Nativity; if it pertain to the Ascendant, look into your *Speculum*, to the Asc. and run down that Collumn till you meet with the Body or Aspect of that Planet which doth denote the Ascendant; then consider the Arch of oblique Ascension, between the Ascendant, and the Planets Body or Aspect, which you make the Promittor, whether it points over or under the time of the Ascendant (allowing 59 minutes 8 seconds for a year) for if so, then the Ascendant must be removed backward or forward, till the Arch of Direction shall exactly corespond with the Time of the Accident; which is thus performed.

Have recourse to the Instrument, and lay the Thred upon the right Ascension of the *M. C.* (in the Limb of the fixed part) then move the divided Semi-diameter, or *M. C.* to lie under the Thred, and there keep it fix'd.

Next find the Declination and right Ascension of the Promittor according to the former Directions.) Rectifie the Bead to the Declination found, and move the Thred till the Bead touch the Ascendant, and let it hang by the weight of its Plumet, then count how many deg. and min. is between the Thred and the right Ascension of the Promittor; and if that Arch (being the Arch of Direction) according to your measure

of

of Time, be too great or too small, for the Natives Age, at the time of the Accident, then you must move the Thred nearer or further, the right Ascension, till the Arch of Direction do exactly correspond; then move the Ecliptick, on upper Moveable, backwards or forwards, till the Bead touch the Ascendant, and there keep it fast; then place the Thred on the beginning of the Circle of the right Ascension, or no deg. thereof, and move the Ecliptick about, till the first point of ♈ lie under the Thred, so will the Ascendant cut the Ecliptick in the Sign and Degree Ascending, and so of the other Houses round the Figure.

Prob. 12.

How to Rectifie a Nativity by the Ascendant.

Suppose a Person Born the sixth day of *August*, the estimate time being about 10 hou. in the Morning, which will be *August* the fifth, 22 hou. past Meridian, at which time the Ascendant is ♎ 18° 30′ in this Latitude. The Native aged 21 years, having an Accident, of the nature of the Ascendant, to the △ of ♀, which fell in 19° 00′ of ♏, by that I Rectifie the Nativity.

First, I find the Declination of the △ of ♀ to be 15° 50′ South, the Right Ascension thereof 219° 46′ and the right Ascension of the *M.C.* 119° 40′, whereto I lay the Thred in the Limb of the fixed

part, and bring the Semi-diameter or tenth House, to lie under the Thred, then I Rectifie the Bead to the Declination 15° 50′ South, after which I carry the Thred about till the Bead touch the Ascendent, letting the Thred hang by the weight of its Plumet; then I count how many Degrees are between the Thred, and the right Ascension of the Promitter 219° 46′, and find it to be 35° 46′, which being too large an Arch, for 21 years, I count 20° 39′ (being the true Arch according to *Naybod's* measure of time, for 21 years) from 219° 46′ towards the Thred, and to that Degree and Minute where the Number ends, which is 199° 7′ I lay the Thred: then I move the Movable about till the Horizon touch the Bead, and there keep it fast; then I lay the Thred on no deg. of right Ascension, on the fixed Limb, and thereto bring the first point of ♈ in the Ecliptick, so I find the Horizon or Ascendant to cut the Ecliptick at 28° 30′ of ♎, and the *M. C.* at 8° 0′ of ♌, and so of the rest of the Houses, the Thred lying in the last Position cuts the Limb of the Movable at 8 hou. 43 min. the right Ascension of the *M. C.* or tenth House.

But if you would know the hour of the day correspondent, proceed thus, take the oblique Ascension of the Ascendent of the Estimate time, agreeing with 18° 30′ of ♎, viz. 206° 18′, to which add 360° the Sum is 566° 18′, from which substract the true corrected oblique Ascension of the Ascendent, 220 deg. and there will remain 345° 22 min. which, converted into time, is *August* the fifth, 23 hou. 2 min. past Meridian, or *August* the sixth, 11 hou. 2 min. in the Morning, which is 1 hou. 2 min. after the Estimate time.

Prob. 13.

Prob. 13.

How to Rectifie a Nativity by the M. C.

TO Rectifie a Nativity by the *M. C.* is very easie; for having, by the Rules aforegoing, get the right Aſcenſion of the Promittor, you need only to frame an Arch from your meaſure of Time, correſpondent to the Natives Age, at the Accident by which you Rectifie, and Subſtract this Arch from the right Aſcenſion of your Promittor aforeſaid, and what remains, ſhall be the right Aſcenſion of the *M. C.* over which, if you lay the Thred in the Limb of the fixed part, it will alſo cut upon the true time of the Day or Night required.

As for Example.

Let the Eſtimate Time of a Nativity be given (as before) on the ſixth of *Auguſt*, at 10 hou. *Mane* 10 which time having Erected my Scheme, and placed the Planets therein, &c. I find ♂ in 23° 30′ of ♌ in the tenth Houſe, and diſtant in right Aſcenſion about 30 deg. from the Cuſp thereof; but having an Accident given at 14 years, and 84 days of the Natives Age, which can be attributed to no other Direction but the *M. C.* to the Body of ♂, I inſpect *Naybod*'s Meaſure of Time, and ſee how many deg. and

min. are correſpondent to the time of the Accident, which I find to be 14° 00′; then I find by the Inſtrument the right Aſcenſion of ♂ to be 146 00′, from which I Subſtract 14° 00′, and there reſts 130° 50′, the right Aſcenſion of the *M.C.* then I bring the divided Semi-diameter, or tenth Houſe, to lie under the Thred, and working as in the laſt Example, I find ♎ 29° 30′ Aſcending, and ♌ 8° 0′ culminating, as before, and ſo of the other Houſes.

Prob. 14.

To Rectifie a Nativity by the ☉ or ☽.

IF in your Scheme or Speculum you find no direction of the Horoſcope, or *M. C.* to ſuit with the Accident given, and you perceive the chief Accident appertain to the Direction of the ☉ or ☽; having Rectified the divided Semi-diameter to the right Aſcenſion of the ſuppoſed time. Firſt then, Conſider what the Arch of Directions muſt be, that will exactly correſpond with the time of the Accident, by which you intend to Rectifie the Nativity; then find the Declinations and right Aſcenſions of the Significator and Promittor, according to the aforegoing Rules; and here it will be neceſſary to have another Thred and Bead to move upon the Centre with the other, then Rectifie the Bead of the one Thred to the Declination of the Significator, and lay

by the Thred on his right Aſcenſion on the Limb of the fixed part, letting it hang by the weight of it's Plumet. Alſo, Rectifie the Bead of the other Thred to the Declination of the Promittor, then Subſtract the deg. and min. correſpondent to the years and days of the Accident, from the right Aſcenſion of the Promittor, and to the Remainder lay that other Thred, keeping thoſe two Threds faſt, till by moving the Moveable about, the Beads on the two Threds lie on one and the ſame Circle of Poſition; which having done, lay one of the Threds on the divided Semi-diameter, and the Thred will ſhew the right Aſcenſion of the *M. C.* Rectified, then if you lay the Thred on 360 deg. or tenth of *March*, and bring the firſt point of *Aries* to lie under the Thred, and ſo proceed (as before) to the finding the Cuſps of the Houſes.

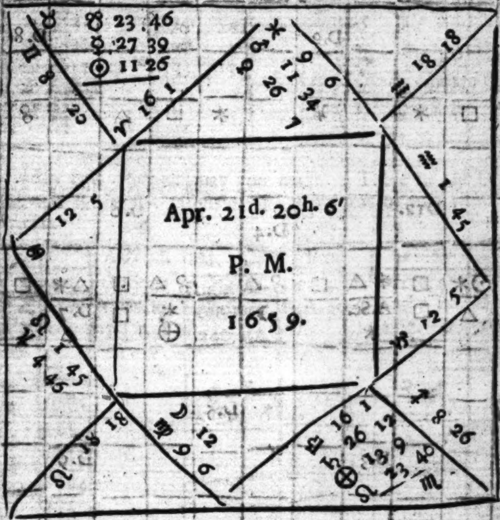
Example.

Suppoſe in ſome Nativities the eſtimate time to be as before *viz.* the Aſcendant 18° 30′ of ♎, and the right Aſcenſion, *M. C.* to be 115° 40′ and that the Native had an Accident of the Nature of ☉ to the Body of ♄, at 18 years, and 108 days of his Age, to which time, according to *Naybod*'s Meaſure of Time, anſwers 18° 0′, then I find the Declination of ☉ to be 13° 30′ North, and of ♄ 3° 0′ South; and the right Aſcenſion of ☉ 145° 14′, and of ♄ 159° 15′; then lay the Thred on 115° 40′, the right Aſcenſion of *M. C.* and bring the divided Semi-diameter to lie under it, and move the Bead to 13° 30′, the Declination of the ☉, and remove the Thred to

his

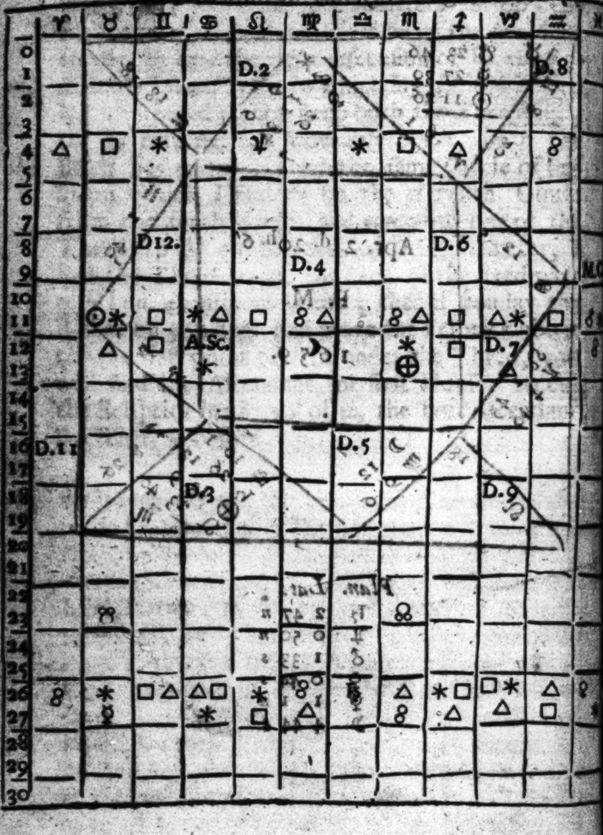
his right Ascension on the Limb, and there let it lie by the weight of its Plumet; then Rectifie the Bead on the other Thred to the Declination of ♄, which is 3° 0′ South, and Substract 18° 00′, the Arch correspondent to the time of the Accident from 159° 15′, the right Ascension of ♄, the Remainder is 141° 15′, to which lay the the Thred last mentioned; then keep both the Threds fast, till by turning the Moveable about, both the Beads lies under one and the same Circle of Position, which I find to be the eleventh Circle from the tenth House, and removing one of the Threds to lie on the divided Semi-diameter, I find the Thred to cut the Limb of the fixed part on 8 hou. 43 min. as before; then if you lay the Thred on 360 deg. and move the Eclptick about till the first point of ♈ lie under the Thred, you will find the Ascendant, or first House, to cut the Ecliptick in 28° 30′ of ♎, the true Ascendant Rectified, as before.

Here follows an Example of a Nativity, truly Rectified, and each Direction work'd out truly, according to *Naybod's* Measure of Time.



Plan.	*Lat.*		
♄	2	47	*n*
♃	0	50	*n*
♂	1	33	*s*
♀	0	44	*s*
☿	1	1	*n*
☽	4	44	*s*

The *Speculum.*



A Table of the Declinations and Right Ascensions of the Promiters of the Asc. & M.C.

Promiter of the Asc.	Declin.		R. Asc.		Promiter of the M.C.	Declin.		R. Asc.	
△♀	21	22 N.	118	10	☍☽	2	45 S.	342	06
□♄	20	59 N.	118	05	✶☉	7	18 S.	342	55
✶☿	21	13 N.	119	47	☌♂	8	3 S.	343	50
☌♃	20	05 N.	127	54	☌♀	2	0 S	356	50
□☉	17	22 N.	133	31	✶☿	1	50 S.	358	00
✶♄	&c.				△♃	2	26 N	4	03
□☿					☍♄	9	8 N	25	13
					□♃	&c.			

After this Method may you make a Table of the Declinations and Right Ascensions of the Promiters of any other Significator.

Years of Age.	An. Dom	Ascend. Oblique Ascension 70 43.	M. C. Right Ascension, 340 43	☉ n. De. 15. 16. R.A. 39. 9.	☽ n. Dec. 2. 52. Right As. 162. 22.	⊕ D. 15. 49. Right As. 220. 31.
0	1659					
1	1660		☍☽	△☽	☍♂	
2	1661		✶☉ ☌♂			
3	1662					
4	1663					
5	1664					
6	1665					
7	1666					☍☿
8	1667			☌☿ ☌☋		☌☋
9	1668					△♀
10	1669			✶♀		
11	1670					
12	1671				△☿	
13	1672					
14	1673				☍♀	
15	1674					
16	1675		☌♀			△♃
17	1676	△♀		✶♃		
18	1677	□♄				

19	1678					
20	1679					
21	1680					
22	1681				✶ ♃	□ ♂
23	1682		△ ♃	□ ♃		□ ☽
24	1683			□ ☽		
25	1684					
26	1685					
27	1686					
28	1687					
29	1688					
30	1689	☌ ♃				
31	1690					
32	1691					
33	1692					
34	1693					
35	1694					
36	1695					□ ♀
37	1696					✶ ♄
38	1697			□ ♀ △ ♄		
39	1698					
40	1699	□ ⊙				
41	1700					
42	1701					
43	1702		☍ ♄		☌ ♄	
44	1703					
45	1704					
46	1705					

Thus have I given you a Synopsis of the whole Calculation, without having any respect to the Distance of a Planet from the Meridian, or Ascentional Difference, Pole of Position, or Oblique Ascension, only by having their Declination, and right Ascension; and thus may you direct any of the other Planets to their Promitors.

FINIS.

A New and most Accurate

PLANISPHERE.

The Second Part.

Wherein is contained the Description and Use of four Circular Lines on the Limb of the Back-side of the Planisphere, *viz. Tangents, Sines, Versed-Sines, and Numbers, commonly called* Circles of Proportion; *whereby all the foregoing* Problems *by help of an opening* Index, *may be Calculated for any* Latitude; *with divers other Uses both in* Arithmetick, Geometry, Astronomy *and* Dyalling.

THE Tangents begin their Division at 35 min. and end at 45 d. and then are returned back again, as if they were continued another whole Circle. The first 4 d. are divided into 60 Parts or Minutes; and from 4 to 10 d. every Degree is divided into 30 parts; or eve-

ry ſecond Minute; and, from 10. to 45 d. each Degree into 12 parts, or every 5 Minutes; from 45, back again with 50, 60, and ſo to 80; from 80, with 81, 82, to 89 d. Theſe laſt Figures are ſmaller than the former, and read the contrary way for the more eaſie Numbring.

The Sines begin their Diviſion where the Tangent doth; the firſt 10 deg. divided in every reſpect as the Tangents are; and from 10, to 40, each Degree is ſubdivided into 12 parts, or every 5th, Minute; and from 40, to 60 d. every Degree into 4 parts or every 15 m. from 60, to 80 d. each ſmall diviſion contains 30 m. from 80 to 85, into every Degree, this Circle is numbred with 1, 2, 3, to 10 d. and from 10, with 20, 30, 40, and ſo to 90 d. and back again with the Complements as the Tangents are.

The Verſed Sines begin their Diviſions at 90 deg. of the Sines, and are numbred backward with 10, 20, 30, *&c.* to 168 d. each Degree being ſubdivided as Quantity would give leave.

The Numbers which lie next the Circle of 360 d. begin their Diviſion at the Semi-diameter which points out VI hours of Right Aſcenſion, and are numbred with large Figures; as 2, 3, 4, and ſo to 10 at the middle; and from 10 in the middle, with 2, 3, 4, and ſo to 10 again, where the Circle begun. Each Space between the ſaid large Figures as far as 4, is divided in 100 parts, every 10 having a longer Stroke than the reſt, and alſo ſmall Figures annexed to them: From 4, the Space between every Figure, is divided into 50 parts; each 10, as before, noted with a longer Stroke, but without ſmall Figures, and are eaſily diſtinguiſhed. I ſuppoſe it needleſs here

to

to acquaint the Reader how to count the Line of Numbers; it is well known if the great Figures be accounted Unites, the Decimals between them, will be Tenths of Unites; if the greater Figures be Tens, the smaller Figures will be Unites; if 100s, the other will be Tens, and the other parts will have a Decimal Proportion; which will be further explained in the Uses afterward.

Having thus described these four Lines, the Uses whereof I shall chiefly apply to the Doctrine of Triangles, I think it may be very necessary and instructive, as well as delightful to the Ingenious Reader, to hint to him the Reason and Ground of the Resolution of all Triangles, that he may not only have Proportions to work by, but may also understand the Reason of those proportions: For which end, I shall first briefly mention the common Definitions of a Triangle, and how the Dimensions thereof are measured; and will illustrate the same by the natural Numbers, and afterwards shew the more facile Operation from the Artificial Numbers, both by the Pen and by the Instrument.

1. A Triangle is a Figure consisting of three Sides and three Angles, and is either Plain or Spherical.

2. A Plain Triangle is constituted of three right Lines; the Sum of any two being greater than the third; the three Angles of which being added together, are equal to two right Angles, or 180 degrees.

3. A Spherical Triangle is composed of three Arches of great Circles of the Sphere; the Sum

of three Angles alwayes greater than two right, and less than six right Angles.

4. Triangles Plain or Spherical are either right, or oblique angled.

5. A right angled Triangle is that which hath one Angle 90 deg.

6. An oblique angled Triangle is that which hath none of the Angles right, each of them being either greater or lesser than 90 deg.

7. The Complement of an Arch or Angle to a Quadrant, is so much as that Arch wanteth of 90 d. as, if one Angle were 60 d. the Complement thereof is 30 d. for 30 and 60 added, is 90.

8. The Complement of an Arch or Angle to a Semi-Circle, is so much as it wants of 180 d. as, if one Angle were 126, the Complement thereof is 54; for 126 and 54 added, is 180.

The Dimensions of all Triangles are found by the Rule of Three; so that the Parts of a Triangle shall have the same relation or proportion to one another, that right Lines and common Numbers have; for as in common Arithmetick, if four Numbers be proportionable, the Product of the two Means is equal to the Product of the two Extreams; that is to say, the second and third multiplied together, is equal to the first and fourth multiplied together: As for Example, Let the 4 Numbers be 6, 9, 12, 18, in these four Numbers 6 and 18 are the two Extreams, 9 and 12 the two Means, and the Proportion between them lies in this, that as the first Number 6. is to the second Number 9, so so is the third Number 12, to the fourth Number 18: Or more plainly, thus; as often

as

as the first Number 6. is contained in the second Number 9. so oft is the third Number 12. contained in the 4th. 18 for as 6 is contained in 9 1 $\frac{1}{2}$. so is 12. contained in 18. Again, the proportion between these four Numbers may as well be thus argued, that as the first Number 6. is to the third Number 12. so is the second Number 9. to the fourth 18. for as the first Number 6. is contained twice in 12. so is the third Number 9. contained twice in 18. and thus may the two middle terms be changed, (which will be of great use in instrumental Operations as afterward,) and yet the Work and the End will be still the same; for 12. Multiplied by 9. is the same as 9. Multiplied by 12. *viz.* 108. which is the Product of the two middle terms; and if you Multiply the two Extremes 6. and 18. the Product is still 108. and therefore the Multiplicat. of the two Means is in effect the Multiplication of the two Extremes, and from hence it follows, that if four Numbers be Proportionable any three of them being given, the other is easily found, as for Example: Let us take only three of the abovesaid four Numbers, *viz.* 6. 9. 12. as 6. to 9. so is 12. to a 4th. now because I know the Product of 9. Multiplied by 12 (which are the two middle terms,) is 108. and that it will be equal to the Product of the fourth Number Multiplied by 6. (the first term) it is evident, that if I Divide the said 108. by 6. the Quotient will be the fourth Number; for 108 Divided by 6. leaves 18. the fourth Number sought: And if this be well minded, the Reader will find no more Difficulty in working a Question, by the Rule of Three, or in resolving a Triangle, the Proportion being assigned than in

in Workiug plain Multiplication and Division.

Now, the better to conceive of the Application of this Rule to the Mensuration of Triangles, I will a little explain, how the Parts of a Triangle are Measured, or what knid of Measures there are apropriated unto them.

First then, For a Spherical Triangle, the Proper and Absolute Measure both of the Sides and Angles are the Arches of great Circles.

Secondly, In plain right-lin'd Triangles, the Angles are measured by the Arch of a Circle desrib'd from the Anguler Point; but the sides which are straight Lines, are measur'd by some known equal Parts: Now that a Proportion of all the Parts of a Triangle one to another may be found and wrought by the *Rule of Three*, it is necessary that the Angles of a plain Triangle, and the Sides and Angles both of a spherical Triangle, be reduc'd to straight Lines, or, if you please, that such right Lines be found out and applied to a Circle, as by them you may as well measure the Angles of a plain Triangle with the Sides and Angles of a spherical Triangle, as if you measur'd the same by the Arches of a Circle, and these Lines are Sines, Tangents, and Secants, all which are Represented in the Diagram, Plate the first, and Figure the first, as for Example: In the Triangle E A B let the measure of the Angle at A be required, the absolute measure thereof is the Arch E B, but this Arch B E is reduced to, or measured by the straight Line B C, which is the Tangent of the said Arch B E, or it is measured by the line D E, which is the Sine of that Arch; or again, it is measur'd by the line A C, which is the Secant of the Arch B E; again,

H E is the measure of the Angle H A E, and is the Complement of the former Arch B E, because both of them make a Quadrant or 90 Degrees: Now this Arch H E is measured by either of the right lines I E, which is the Sine thereof or H G the Tangent or A G the Secant of the said Arch. Now that these lines of Sines, Tangents and Secants, may be applied to the Mensuration of a Tringle; there are certain Numbers of Equal Parts, proper to each of them found out, and drawn into Tables, which are called the Natural Sines Tangents and Secants, and these Tabuler Numbers have the same proportion one to another, that any three plain and common Numbers have; and that this may be fully apprehended, the Reader must know, that the Natural Numbers proper to the Sines, Tangents and Secants are found out by the Proportion they bear to the Radius or Semi-diameter of a Circle, and the Radius may be supposed a 100, 1000, or 10000 equal Parts, (or much more if you please) and then shall the Sines, Tangents and Secants be all constituted from these equal Parts, according to their Proportion to the Radius: The Sine of 90 deg. is equal to the Radius which is Represented in the first *Fig.* by A B, and therefore all the Sines less than 90 deg. will be less than the Radius, the Secant of 00 deg. which also is A B or A E, is equal to the Radius, and therefore the Secant in the Table of every Degree is more than the Radius; for the Secant is the excess of a line (drawn from the Centre) more than the Radius or Semi-diameter, 'till it meet with the Tangent in the Diagram E C; and this E C added to the Rad. A E makes the Secant, A C the Tangent of 45 deg.

deg. which in the Diagram is B P or H P is equal to the Radius, and therefore all the Tangents in the Tables, less than 45 deg. are less than the Radius, &c. And for the Arithmetical framing of each of these, mind the following Examples. If A B the Radius be assumed 10000 equal Parts, then will D E, the Sine of the Angle E A D 30 d. be found 5000 of like Equal Parts; for E D O, the double of E D, is the Chord or Substance of 60 deg. equal to the Radius A B 10000, and therefore E D being the half of E O, must needs contain 5000, and is equal to A I. Again, having found D E or A I 5000, which is the half of the Rad. A B 10000, you may also find E I equal to A D the Sine of the Angle H A E 60 deg. in the like equal Parts; for if E D 5000 Multiplied into it self be Substracted from A B 10000 Multiplied in it self, the square Root of the Remainder will be E I 8660 of the same equal Parts, which is the Natural Sine of 60, and so may the rest of the Sines be found; but I intend not here, nor in what follows, to put the Reader upon making a Table of Sines, &c. or to resolve Triangles by them, but only briefly to hint the Nature of these Lines, and how Triangles are resolved by them. I might also shew how the Tangents and Secants are brought into Numbers of like Parts with the Radius 10 By help of the Sines being first made, the Proportion for the Tangents is as the Sine Complement of an Arch to the Sine of that Arch, so is the Radius to the Tangent of the same Arch: As, suppose I would have the Tangent of 30 deg. if I Multiply the two Middle Num. (in the Proportion last mention'd,) viz. the Radius, which is 10000 equal Parts, by the Sine of 30 deg. which is

is 5000 of the same parts, and then divide the Product by the first Term, which is the sine of 60 d. *viz.* 8660, the Quotient shall be the Tangent sought, 5773 : so for the Secants, if the Radius be multiplied in it self, and the Product divided by the Sine-complement of the Arch sought, the Quotient will be the Secant sought : But if any desire to be fully informed in the Construction and making of these Tables, they may be satisfied in Mr. *Newton's* Trigonometry, *Pitiscus*, and others.

But I intend not a Doctrine of Trigonometry, nor any thing further than hath been already said : Therefore having thus shewed how the Arches of Circles are brought into straight Lines by the sines, tangents and secants, and that the natural Numbers of these are formed by their Proportions to the Radius ; and also how they mutually make and produce one another, it will plainly appear, that to resolve a Triangle by them, is no more than to work the Rule of Three in common Numbers, only with this difference, that whereas in common Arithmetick, the simple Numbers only are made use of, but by these Lines it is the Tabular Numbers proper to each Line ; whereby the Proportion must be wrought : As for Example ; If I would work this Proportion ; As the Sine of 6 d. is to the Sine of 9 d. so is the Sine of 12 d. to a 4th. I must not here for the several Sines of 6, 9, 12. make use of their proper Numbers, *viz.* to multiply 9, by 12, and divide by 6, (as before) but I must take out the Sines of those Numbers 6, 9, 12, from the Tables, and then will the Operation be the same in all respects, as if I wrought

with

with the simple Numbers themselves; for the Sine of 9 d. (156) multiplied by the Sine of 12 d. (208) and the Product divided by the Sine of 6 d. (105) the Quotient is the Sine sought, 311 18° 8'. And if I were to work by Sines and Tangents together, the Work will be still the very same: And further, if I were to work with Sines (or Tangents) and straight Lines in a mixt Proportion, as in plain Triangles, the Work alters; not only therein you use the proper Number belonging to the straight Line; but take the Sine or Tangent out of the Table: For if I say; As the Sine of 6, is to a Line of 9 Feet; so is the Sine of 12, to a 4th. then I take the Sine of 12 d. which is one middle Term, from the Tables, and multiply it by 9 feet, the other middle Term, and then divide that Product by the Sine of 6, taken from the Tables, the Quotient will be the 4th. Number sought; which will be almost 18 feet: and so of any other; as shall be further explained in the following Work.

Let it be further minded, That the Lines of Sines, Tangents and Secants, being so drawn within and without the Circle, constitute several equiangled Triangles, from whence the Proportion of them one to another, is most certainly inferred; for if a Line be drawn parallel to any side of a Triangle, as the Sine and Tangent of the same Arch will always be, the Triangle shall be cut proportionably by them:

As for Example;

Let A, B, C, be a Triangle, and then shall E D, the Sine of the Angle at A, be parallel to B C, the Tangent of the said Angle, and shall cut

cut the said Triangle proportionably, *viz.* You may from thence argue as follows: That as AB, the Radius or Tangent 45 d. 00 m. is to A D, the Sine of 60 d. 00 m. so is B C, the Tangent 30 d. to E D, the Sine 30 d. *viz.* whatever parts of A B, A D doth contain, so many parts of B C doth D E contain; or if you please, A D multiplied by B C, equal to A B, multiplied by E B.

Again, as A D is to AB, so is A E to A C; *viz.* as the Sine of 60, to Rad. or 90° so 90° to the Secant of A C. Abundance of other Proportions may hereby be deduced; for we may as well argue, that as B C is to E D, so is A B to A D, which is only the converse or backward Work of the first Proportion.

The Reader may form many more Proportions if he pleases; these may serve, a little to shew the Resolution of Triangles by the Sines, Tangents, &c. Which I will further illustrate in an Example or two, by the Natural Numbers.

Plate 1. *Fig.* 1.

Let A K l be a Spherical Triangle: Let there be given the Base A K; the Sine thereof is 7660, and the Angle at the Base 30 d. the Sine thereof D E, 5000, or B C the Tangent 5773: Let be required to find the Perpendic. K L, the Sine of the said Perpendicular is n L, and K m the Tangent; the Proportion is,

Example

Example I.

As AB Radius, or ——————— 10000
Is to the Sine of the Base AK 40 d. —— 6428
So is BC the Tang. of the Ang. at A 30 d. — 5773
To Km the Tang. of the Proper. 20 d. 22′. - 3710

I think it needless to work this out at length, so much being said of it before; but if the Reader be minded to do it multiply the two middle Numbers together, and from the Product, cut off four Figures toward the right hand, and the Remainder will be the 4th. Number sought; and the like of any other, the Radius being put in the first place.

Example II.

Again, if we suppose the Triangle ACB in the former Diagram, to be a right-lined plain Triangle, and have given there in the Line AC in some known equal parts, which let be 120 Feet, and the Angle at A 30 d. Let BC be required, the Proportion will be,

As Rad. or 90 d. the Sine whereof is 10000
Is to the given Line AC ——————— 120
So is the Sine of the Angle at A 30 d. — 5000
To the Line BC ——————————— 60

The Operation is the same as before.

I intended here briefly to have laid down the common Axioms of Trigonometry, and have

have shewed how the following Proportions are deduced from them; but when I considered the explaining of them would take up more room than I am allowed here, and that they are fully handled by Mr. *Gellibrand*, *Norwood*, and others, I thought it better to refer the Reader thither; hoping that what hath been here said, will help him the more delightfully to look into, and use those Authors, if he think fit so to do; and that it will prevent his being amused at the Proportions that are hereafter mentioned; which I shall now proceed to shew the working of by the Artificial Lines on the Instrument, and also by the Pen, from the Artificial Sines and Tangents in the Tables, which are nothing else but the Logarithms of the Natural; but far more easie in the Use thereof. So that here Addition serves instead of Multiplication, and Substraction instead of Division; which will be plain in divers Examples following.

How to Work Proportions by the Artificial Lines of Numbers, Sines and Tangents.

THE said Lines are to be used either with Compasses or a Sector opening upon them; but we shall suppose them all along to be used with the Sector, only the inside of the Legs of the Sector are cut away, and supplied by strings fixed thereto, which strings are supposed to proceed from the Center of the Sector; and these strings we shall afterwards call the Legs

of

of the Sector, and in the using thereof, observe the following Rules.

1. That any Leg of the Sector being laid upon the first Term of the Proportion, I do in that Operation call the first Leg; and the other Leg being opened to the second or third Term, I call the second Leg.

2. That when you work by the Numbers only, lay one Leg on the first Term of the Proportion, and open the other to the second Term; then lay the Leg which lay on the first, to the third Term, and the other will lie over the fourth Term required; or, according to the first Rule, open the Legs to the first and second Terms, and bring the first Leg to the third Term, then shall the second Leg lie over the fourth Term. But,

3. When you work on the Tangents, or on Numbers, Sines or Tangents together in mixed Proportions, let it be well minded what is said in the Description of the Tangent-Line, and what is further noted here. that although it be continued no farther than 45 deg. which takes up one Circle, yet being returned back again, hath the same Use as if it were continued quite round in a new Circle; for if the Instrument be laid right before you with the Word *DECEMBER* next unto your Breast, then does the Tangent on the opposite side begin about 35′, and proceeds round from the Left Hand towards the Right to 45°, ending where it did begin; but then for the Tangents beyond 45°, they do not move forward, or the same way from the Left Hand to the Right, but back again from the Right Hand to the Left; yet in the Operation,

may

may be ſuppoſed ſo to do, and muſt be uſed as if they did.

As for Example.

If I ſhould ſay, As the Tangent of 20, is to the Tangent of 30, ſo is the Tangent of 40 to a Fourth.

To work this, do thus; Open the Legs of the Sector to 20 and 30, the two firſt Terms, then move the firſt Leg (or that which lay over 20) to 40, the third Term, then will the ſecond Leg fall beyond 45, towards the right hand, whereas the ſame diſtance from 45, towards the left hand, would indeed give me the fourth Term I ſeek for; therefore keeping the ſecond Leg where it is, I bring the firſt to 45 d. and then bring the ſecond to 45 d. and then the firſt Leg toward the left hand, will lie over the Tangent ſought, *viz.* 53 d. 5 m.

But when you work with Sines and Tangents together, or Tangents and Numbers together, *&c.* then may you change the two middle Terms of the Proportion, and ſave the former trouble; for it matters not (as hath been ſhewed) which of the middle Terms are put before the other, provided you carefully obſerve the Increaſe or Decreaſe of the Proportion; for if you open the Legs of the Sector (ſuppoſe) from the firſt Term to the third, in a forward Proportion, then muſt the ſame diſtance of the Legs be ſet from the ſecond to the fourth, in the like Proportion; if the third Term be greater than the firſt, the fourth will be greater than the ſecond; if the firſt be greater than the third, the ſecond will be greater than the fourth, *&c.*

As for Example.

On the Sines and Tangents together: As the Sine of 90 d. is to the Sine of 30 d. so is the Tangent 51° 32′ to a fourth. Now it is plain, that this is a backward Proportion, the second Term being less than the first, and therefore the fourth will be less than the third. And because the working of this Proportion, as it is laid down, will be somewhat more trouble than to change or transpose the two middle Terms, therefore I would work it thus; As the Sine of 90 d. is to the Tangent 51° 32′, so is the Sine of 30 d. to a fourth: And now I work in a forward Proportion; and if I open the Legs of the Sector from the Sign of 90 d. to the Tangent of 51° 32′, towards the left hand, and bring the second Leg to the Sine of 30 d. the first Leg (or that which lay towards the right hand) will give me the Number sought.

And although in most Operations, always on the Numbers single) the same way that the second Leg is opened from the first, the same way will the second lie from the first, for the Answer of the Question; yet because of the returning of the Tangents, &c. that Order in all such Operations, as does require the continuation of the said Line beyond 45 d. is inverted, but I hope cannot in the least stumble any Practitioner, if he do but consider either the Increase or Decrease of his Proportion; which will be made more plain in divers other following Operations. And what hath been said of the Tangents in the first Example, may also help the Reader in using of the

the Sines, which return back again where the Tangents do; but if any Arch be sought or made use of upon the Sines above 90 d. then take the Complement of the same to 180 deg. or call 80 100, 70, 110, 60, 120, &c. and the Work shall be the same: And before I give any Examples, I would advise the Reader throughly to understand the Division of each of these Lines, and be perfect in the reading and numbring of them, and then he will find no difficulty in the following examples.

Example,

1. By the Line of Numbers only.

1. *To Multiply one Number by another, the Proportion is,*

As 1 is to the Multiplier, so is the Multiplicand to the Product; that is, lay one Leg of your Sector on 1, in the Line of Numbers, and open the other to the Multiplicator; then lay the first Leg on the Multiplicand, and the second Leg will shew the Product:

As if you would multiply 12 by 9, the Product will be found to be 108, &c.

2. *To Divide one Number by another.*

As the Divisor is to 1, so is the Dividend to the Quotient.

As, if you would divide 108 by 9, the Quotient will be found to be 18; for if you lay one Leg of the Sector on 9, the Divisor, and open the other to 1, then lay the first Leg on 108, the Dividend, and the second Leg will lie on 18, the Quotient, &c.

3. *To extract the Square and Cube Roots by the Line of Numbers.*

Divide the ſpace between 1, and the Number given, into two equal parts, and that Diviſion where the middle falls, is the Square Root; for if you would find the ſquare Root of 144, the middle between it and 1, is at 12, the Root ſought.

But for the Cube, divide the ſpace between 1, and the given Number, into three equal parts, one of which parts being counted or laid from 1, that gives the Cube Root ſought; ſo that if the Number were 1331, the Root thereof will be found to be 11, &c.

4. *To work the Rule of Three by the Rule of Numbers.*

As 6 Feet or Miles is to 9 Feet or Miles, ſo is 12 Feet, &c. to 18 Feet, &c.

Open the Legs of your Sector to the two firſt Terms, 6, and 9, in the Line of Numbers, then lay the firſt Leg on 12, the third Term, and the ſecond Leg will lie on 18, the fourth Proportion.

Or by the Table of Logarithms, thus;

As 6, the Log. thereof is	0,77815
Is to 9, its Log.	0,95424
So is 12, &c.	1,07918
	2,03342
To 18,	1,25527

This

This is done by adding the Logarithms of the second and third Term, and substracting the Logarithm of the first from the Sum, and the Remainder is Log. of the fourth Proportion.

5. *To work Proportions by Sines.*

As the Radius or Sine of 90° 00′, is to 30° 00′, so is 23° 30′, to the Sine of 11° 30′.

Lay the first Leg on the Sine of 90 d. and open the second Leg to the Sine of 30° 00′, and then move the first Leg to the Sine of 23° 30′, and the second Leg will lie on 11° 30′, the fourth Term sought.

By the Logarithms of Sines.

As Radius or Sine of 90° 00′, —	10,000000
Is to the Sine of 30° 00′ —	9,6989700
So is the Sine of 23° 30′ —	9,6006997
To the Sine of 11° 30′ —	9,2996697

6. *To work Proportions by the Sines and Tangents joyntly.*

As the Radius or Sine of 90° is to the Sine of 51° 28′, so is the Tangent of 30° 00′, to the Tangent of 24° 18′.

Lay the first Leg of the Sector on the Sine of 90° 00′, and open the second Leg to the Sine of 51° 28′; then lay the first Leg on the Tangent

Tangent of 30° 00′, and the second Leg will lie on the Tangent of 24° 18′.

By the Log. Sines and Tangents.

As the Radius or Sine of 90 d. —— 10, 000000

Is to the Sine of 51° 28′, —— 9893343[illegible]
So is the Tangent of 30° 00′, —— 97614394

To the Tangent of 24° 18′, —— 96547827

7. *To work Proportions by the Numbers, Sines and Tangents.*

As the Sine of 90° 00′, is to 120 feet or miles,
So is the Sine of 30°, to 60 feet or miles.

Lay one Leg on the Sine of 90°, and open the other to 120 on the Line of Numbers, and then lay the first Leg on the Sine of 30 deg. and the second Leg will lie over 60 feet or miles on the line of Numbers.

By the Tables of Log. and Sines.

As the Radius 90° 00′, —— 10,0000000
Is to 120 feet, &c. —— —— 2,0791812
So is the Sine of 30° 00′ —— 9,6989700

To 60 feet, &c. —— —— 1,7781512

Again,
8. As the Sine of 90° is to 60 feet, &c.
So is the Tangent of 60′, to 104 *fere.*

To

To resolve this Proportion of Tangents; lay the first Leg of the Sector on the Sine of 90°, and open the other to the Tangent of 60° (which is the third Term) then move the second Leg to 6°, on the line of Numbers, being the first Term, and the second Leg will lie on 104, of the said Line.

But for the further Explanation hereof, I will add two or three Examples more.

9. As the Sine of 90° 00′, is to the Sine of 51°28′.
So is the Tang. of 56°00′, to the Tang. of 49°15′.

Lay the first Leg of the Sector on the Sine of 90°, then open the other to the Sine of 51° 28′, then lay the second on the Tangent 56 d. 00 m. and the first will lie on the Tangent of 49°, 15′, the fourth term sought.

By the Tables of Artificial Sines and Tangents.

As the Sine of 90°	10,000000
Is to the Sine of 51° 28′,	9,893544
So is the Tangent of 56° 00′,	10,171012
To the Tangent of 49° 15′,	10,064556

10. As the Sine of 90°, is to the Sine of 51° 28′,
So is the Tang. of 47° 00′, to the Tang. of 40° 00′.

Lay one Leg of the Sector on the Sine of 90°, the first Term, and open the other to the Sine 51° 28′, and then lay the second Leg on the Tangent

Tangent of 47° 00′, and the first Leg will fall beyond the Tangent of 45 d. then if you move the second Leg to 45 d. bringing the first Leg to 45°, and the second will lie on 40 d. the 4th Term sought; otherwise by changing the two middle Terms.

Lay one Leg on the Sine of 90 d. the first Term, and open the other to the Tangent of 47 d. 00′, the third Term; then lay the second Leg on the Sine of 51 d. 28′, and the first Leg will rest at the Tangent of 40 d. 00′, as before.

11. As the Sine of 23° 30′ is to the Radius or Sine of 90° 00′.

So is the Tangent of 36°, to the Tangent of 61° 14′.

This Proportion is to be done as the last was; for if you lay one Leg on the Sine of 23 d. 30′, the first Term, and open the other to the Sine of 90 d. then move the first Leg to the Tangent of 36 d. 00′, the second Leg will fall off the Circle (that is, beyond the Tangent of 45 d.) so that if you change the middle Terms, as before (that is) laying the first Leg on the Sine 23 d. 30′, and open the other to the Tangent of 36 d. the third Term; then move the second Leg to the Sine of 90 d. being the second Term, the first Leg will lie on the Tangent of 61 d. 14′, the fourth Term sought.

One Example more, and then proceed; (and that is) when the fourth Term will be less than 35′ r, as in the following Example.

12. As

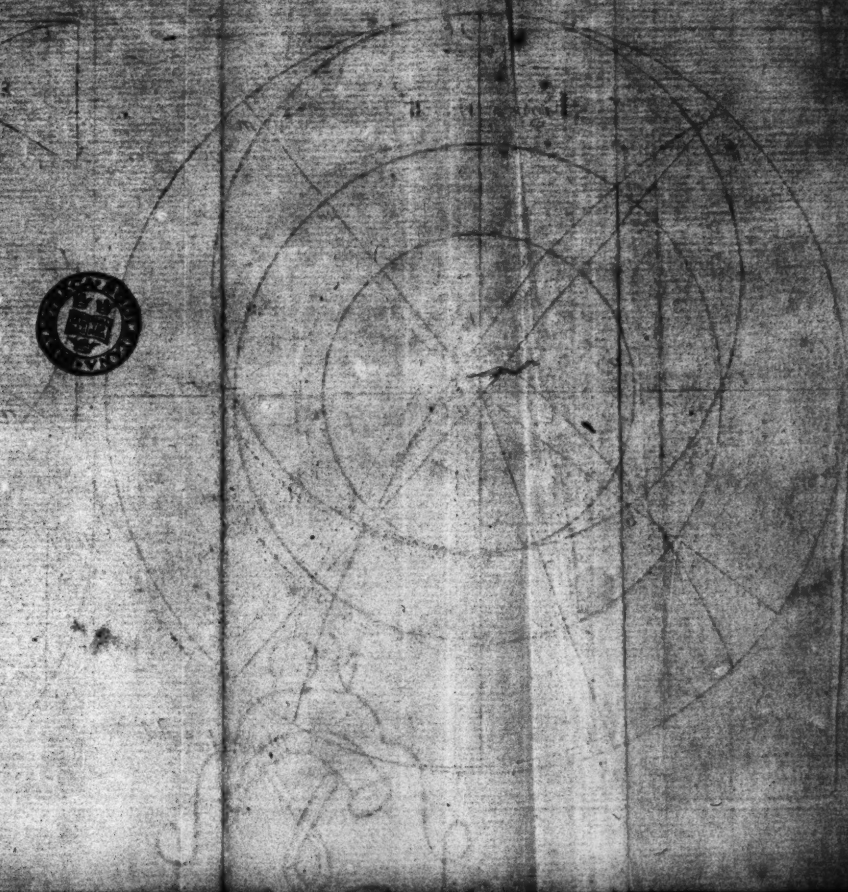


Figure the II^d

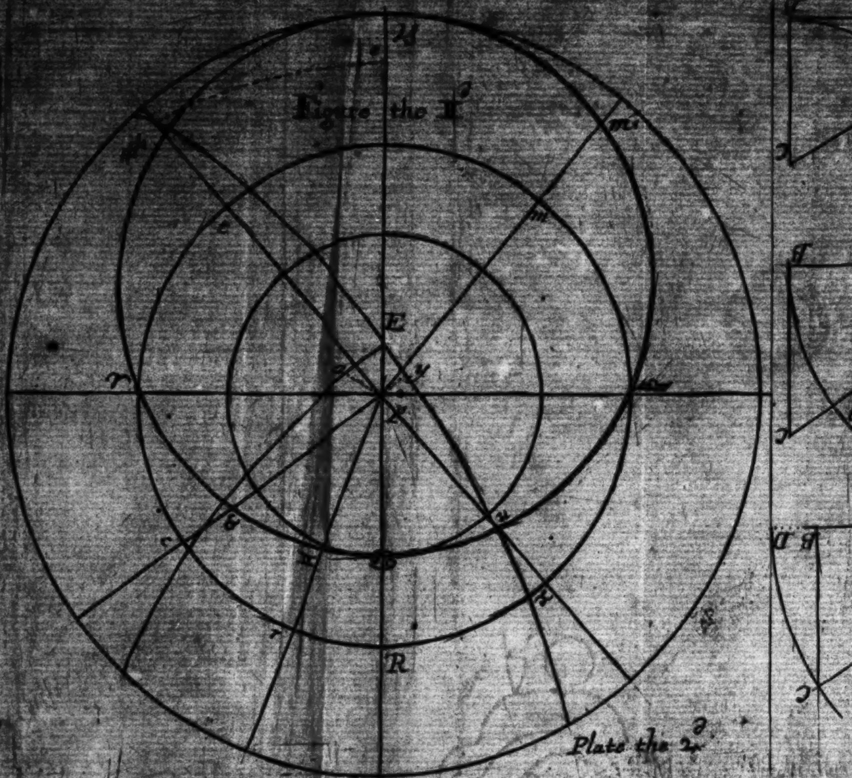
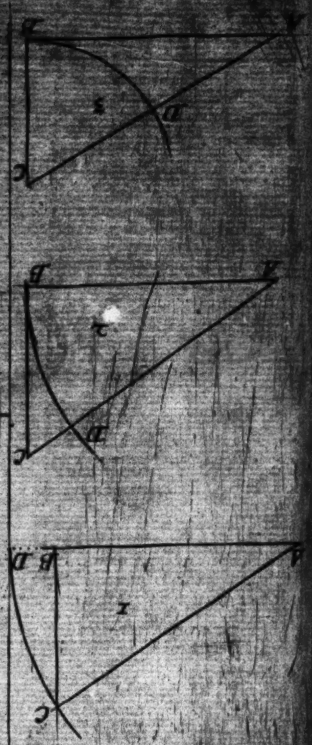


Plate the 2^d



12. As the Sine of 90° is to the Sine of 13° 45′,
So is the sine of 2° 15′, to the Sine of 00° 32′.

Lay one Leg of the Sector on the Sine of 90 d. and open the other to the Sine of 13 d. 45 m. then move the first Leg to the Sine of 2 d. 15 m. and the second Leg will fall beyond the beginning of the Circle; and in this, and in all other such like Proportions, you must convert the Degrees of the third Term into Minutes; which in this Example is 135 min. then lay the first Leg of the Sector on 135, in the Line or Circle of Numbers, and the second Leg will rest at 32 min. of the said Line, which is 32 min. the fourth Proportional.

And thus having shewed how to work Proportions by the several Circles, as also how the same is performed by the Tables of Artificial Numbers, Sines and Tangents; so that what hath been said in these Examples, is sufficient for the understanding of any other; therefore I shall be brief in that which follows; First, in explaining the several Triangles in the Schemes following; which represent their correspondent Triangles in the *Planisphere*; and then lay down the Proportions of each Problem Trigonometrically.

The Explanation of the Second Figure.

1. The outermost Circle represents the Tropick of *Capricorn*, on the Backside (which is sometimes fitted up to lie under the other, the outmost Circle being common to both) of the *Plani-*

nisphere, ♈, *r*, ♎, represents the Equinoctial; and the innermost Circle represents the Tropick of *Cancer*, and *p*, the North-Pole, E the Pole of the Ecliptick, ♈ ♎ ♊ the Ecliptick, E ♉, E ♒, are Circles of the Longitude of the Sun or Planets, representing those Arches of Longitude, which are drawn through the Ecliptick and Parallels of Latitude.

p ♉, *p* ♊, *p* ♏, *p* ♒, are Meridians, which represent the Thred or Leg of the Sector at several Positions; so that these Circles of Longitude and Meridians, with the Solsticial Colures, constitute several Triangles, so that any three parts of each Triangle being known, the rest may be found.

As in the Triangle ♈, ♊, *r*, right angled at R.

2. Let ♈, ♊, the Suns Longitude from *Aries* be 75 d. 00 m. and the Angle at *Aries*, the Suns greatest Declination, 23° 30′, and let the Perpendicular ♊ *r*, be required, which is the Suns present Declination.

The Proportion is thus;

As the Radius or Sine of 90°, 00′,
Is to the Sine ♈ ♊, the Suns Distance from ♈, 75° 00′,
So is the Sine of the Angle at ♈, 23°, 30′,
To the Sine of ♊ *r*, 22°, 40′, the Suns present Declination.

Again,

Again,

In the Triangle ♎ ♏ *m*, right angled at *m*, let the Sun be in ♏, in 23° 45′ thereof, the Angle ♎ being 23° 30′, the Suns greateſt Declination; and let ♏ *m* be required, the preſent Declination.

As the Radius or Sine of 90 d. 00 m.
Is to the Sine of ♎ ♏, 53 d. 45 m. the Diſtance from ♎.
So is the Sine of the Angle at ♎, 23 d. 30 m.
To the Sine of ♏ *m*, 18 d. 45 m. the Declination of the Sun South.

3. *The Suns greateſt Declination, and preſent Declination being given; to find his Place in the Ecliptick.*

In the Triangle ♈, ♊, *r*, let ♊ *r*, the preſent Declination, be 22 d. 40 m. the Angle ♈, 23 d. 30 m. be given, and ♈ ♊ be found.

As the Sine of the Angle ♈ 23 d. 30 m. the greateſt Declination,
Is to the Sine of ♊ *r*, 22 d. 40 m. the preſent Declination,
So is the Radius or Sine of 90 d. 00 m.
To the Sine of ♈ ♊ 75 d. 00 m. the diſtance of the Sun from ♈, which is in 15 d. 00 m. of ♊.

And ſo in the Triangle ♎ ♏ *m*, let ♏ *m*, be 18 d. 45 m. and the Angle at ♎, be 23 d. 30 m. and let ♎ ♏ be found.

As the Sine of the Suns greatest Declination, 23 d. 30 m. the Angle at ♎,
Is to the Sine of the present Declination 18 d. 45 m. ♏ *m*.
So is the Radius or Sine of 90 d. 00 m.
To the Sine of the Suns distance from ♎, 53 d. 45 m.

4. *The Suns Place being given, with his greatest Declination, to find his Right Ascension.*

In the right angled Spherical Triangle ♈ ♊ *r*, let there be given ♈ ♊, 75 d. 00 m. the distance of the Sun from *Aries*, which is in 15 d. 00 m. of ♊, and the Angle at *Aries*, 23 d. 30 m. the greatest Declination; and let *Aries*, *r*, the Right Ascension, be required.

As the Sine Compl. of the greatest Declination, 23 d. 30 m. the Angle at *Aries*.
Is to the Radius,
So is the Tang. Compl. of the Suns Longitude, ♈ ♊, 75 d. 00 m.
To the Tangent Compl. of the Right Ascension, *Aries*, *r*. 76 d. 12 m.

Which 76 d. 12 m. being converted into time, is 5 h. and 5 m, the Right Ascension sought.

And so the Sun being in 23 d. 45 m. of ♏, the Right Ascension will be found to be 231 d. 21 m. for in the Triangle ♎ *m* ♏, we have given *Libra*, *Scorpio* 53 d. 45 m. the Suns Distance from *Libra*, with the Angle at *Libra*, the greatest Declinat. to find *Libra*, *m*, in the right Ascension.

As the Sine Compl. of the Angle *Libra*, 23 d. 30 m.
Is to the Radius 90 d. 00 m.
So is the Tangent Compl. of *Libra* and *Scorpio* 53 d. 45 m.
To the Tangent Complement of *Libra* ♏. 51 d. 21 m.

Which 51 d. 21 m. is the right Aſcenſion from *Libra*, to which if you add 180 d. 00 m. the Sum is 231 d. 21 m. the right Aſcenſion from *Aries*.

And ſo by theſe Proportions you may find the Declination and right Aſcenſion of any Star or Planet, without Latitude: we come in the next place to find the Declination and right Aſcenſion of any Star or Planet with Latitude, either North or South.

5. *Suppoſe then a Planet or Star to be in* 2 d. 00 m. *of* Taurus, *with* 5 deg. 00 min. of *South-Latitude, his Declination and right Aſcenſion is required.*

In the Oblique Angled Triangle E, *p*, ♉, we have given E *p*, 23 d. 30 m. (equal to the greateſt Obliquity of the Ecliytick, or the Diſtance between E, the North-Pole of the Ecliptick, and *p*, the North-Pole of the World,) and E, ♉, 95 d. 00 m. the diſtance of the Planet from the North-Pole of the Ecliptick, with the Angle at E, the diſtance of the Planet from ♋, 58°, 00.

To

To find the Angle at p, the right Ascension, and the Side p ♉, the Distance of the Planet from the North-Pole or Complem. of the Declination.

To resolve this Proposition, requires two Operations; so the Triangle must be divided into two right Angled Triangles, letting fall a Perpendicular from *p*; as *p a*: then the Proportion is, for the Declination:

As the Radius or Sine of 90 d. 00 m.
Is to the Tangent of *p* E, 23 d. 30 m.
So is the Sine Compl. of the Angle at E, 58 d. 00 m.
To the Tangent of E *a*, 13 d.

Which 13 d. being substracted from E ♉, 95 d. 00 m. there remains *a* ♉, 82 d.

Then for the Second Operation.

As the Sine Compl. E *a*, 13 d. 00 m. the Arch last found.
Is to the Sine Compl. of E *p*, 23 d. 30 m.
So is the Sine Comp. of *a* ♉, 82 d. 42 m.
To the Sine Compl of *p*, ♉, 82 d. 13 m. that is ♉ *c*, 7 d. 47 m. the Declination.

For the Right Ascension, viz. *the Angle at p.*
As the sine of *p* ♉ 82 d. 13.
Is to the sine of the Angle at E, 58 d.
So is the sine of E ♉ 95° 00′, or 85°, its compl.
To the sine of the Angle at *p*, 58 d. 30 m.

This

This Angle at *p*, 58 d. 30 m. is the outward Angle R *p c*, or the Arch R *c*, which being substracted from 90 d. 00 m. *Aries* R, there will remain *Aries*, *c*, 31 d. 30 m. the right Ascension sought.

Again,

6. *Suppose a Planet or Star, in* 10 d. 00 m. of *Aquarius*, *with* 4 d. 00 m. *of South-Latitude; the Declination and right Ascension is required.*

In the Oblique Angled Spherical Triangle, *p* E ♒, we have given *p* E 23 d. 30 m. as before, and E ♒, 94 d. 00 m. the distance of the Star or Planet from the North-pole of the Ecliptick, with the obtuse Angle at E, the distance of the Star from ♋, 140 d. 00 m. or the outward Angle at E, the distance from ♑, 40 d. 00 m. the Arch ♑ ♒, To find *p* ♒, the Compl. of the Declination, or the distance of the Star from the North-pole, and the Angle at *p*, the right Ascension.

In this Example the Perpendicular must fall without the Triangle, as, ♒ *e*; then the Proportion holds for the Declination.

As the Radius
Is to the Tangent of ♒ *e*, 94 d. 00 m. or the Compl. thereof to 180 d. *viz.* 86 d. 00 m.
So is the Sine Compl. of the outward Angle at E 40 d. 00 m.
To the Tangent of 84 d. 46 m. which is the Compl. E e, to 180.
So that E e is 95 d. 14 m.

Then

Then to E ♉ 95 d. 14 m. add E ♇, 23 d. 30 m. the Sum is ♇ ♉, 118 d. 44.

Then,

As the Sine Comp. of E ♉, 95, 14, or rather, 84 d. 46 m.
Is to the Sine Compl. of E ♒ 94 d. 00 m. or 86 d. 00 m.
So is the Sine Compl. of ♇ ♉, 118 d. 44 m. or 61 d. 16 m.
To the Sine Compl. of ♇ ♒, 111 d. 58 m. or, 68 d. 2 m.

From ♇ ♒, 111 d. 58 m. substract P ♈ 90 d. 00 m. there will remain ♈ ♒, 21 d. 35 m. which is the Declination South.

Secondly, *For the Right Ascension, the Angle at* ♇.

As the sine of ♇ ♒, 118 d. 44 m. the distance from the North-pole, or its Compl. to 180 d. 61 d. 16 m.
Is to the sine of the Angle at E, 140 d. the Planets Long. from ♋, or the outward Angle 40 d. its distance from ♑,
So is the sine of E ♒, 94 d. 00 m. or its Comp. to 180 d. *viz.* 86 d. 00 m.
To the sine of the Angle at ♇, 43 d. 43 m. the distance in right Ascension from ♑, which being added to 270 d. 00 m. the Sum is 313 d. 43 m. the right Ascension.

This

This Proportion may be wrought otherwiſe, and ſo may all thoſe that have South-Declination; for if we ſuppoſe the North-pole to be the South-pole, the Tropick of ♑ will repreſent that of ♋, and the Tropick of ♋ will repreſent the Tropick of ♑; and ſo every point of the Projection ſhall repreſent his contrary.

For Example.

Let a Planet or Star be in 10 d. 00 m. of ♒, with 4 d. 00 m. of South-Latitude, as before; and his Declination and right Aſcenſion is required.

In the Oblique Angled Triangle E *p u*, where *p*, repreſents the South-pole, and E the South-pole of the Ecliptick, and *u*, the place of the Star or Planet.

The Proportion for the Declination, is,

As the Radius
Is to the Tangent of *p* E, 23 d. 30 m.
So is the ſine Comp. of the Angle at E 40° 00′, the diſtance from ♑,
To the Tangent of E *y*, 18 d. 35 m.

Which 18 d. 35 m. being ſubſtracted from E, *u*, the Comp. of the Latitude, there will remain *y u*, 67 d. 35m.

Then,

As the ſine Comp. of E *y*; 18 d. 35 m.
Is to the ſine Comp. of E *p*, 23 d. 30 m.
So is the ſine Comp. of *y u*, 67 d. 25 m.
To the ſine Comp. of *p u*, 21° 35′, as before.

For the Right Aſcenſion.

As the ſine of *p u*, 68 d. 25 m. the Comp. of the Declination,
Is to the ſine of the Angle at E, 40 d. 00 m.
So is the ſine of E *u*, 86 d. 00 m. the Comp. of the Latitude.
To the ſine of the Angle at *p*, 43 d. 43 m.

This 43 d. 43 m, is the ſine of the outward Angle at *p*, *viz.* ♋, *p*, *u*, or the Arch of the Equinoctial R *x*, the right Aſcenſion from the firſt point of ♑; which being added to 270 d. 00 m. the right Aſcenſion of R, the aforeſaid Point; the ſum is 313 d. 43 m. the right Aſcenſion of the Point *x*, as before.

And thus, according to theſe Analogies, you may find the Declination and right Aſcenſion of any Point of the Ecliptick, with Latitude, or without; all which is performed without having any reſpect to the Latitude of the Place; they being the ſame in all Latitudes: ſo that what follows, is done with a reſpect to a particular Latitude.

7. *The Latitude of the Place, and Declination of the Sun or Star being given; to find the Amplitude.*

In the right angled Triangle *r* L *o*, in the third Scheme, which is compoſed of L *r*, an Arch of the Equinoctial, and L *o*, an Arch of Horizon, and *r o*, an Arch of a Meridian paſſing through the Center of the Sun or Star at his Riſing or Setting. *Example.*

Example.

Suppose the Sun to have 10 d. 32 m. of North Declination in the Latitude of 51 d. 32 m. and let it be required to find the Amplitude at his Rising or Setting.

As the Sine Comp. of the Latitude 51 d. 32 m. the Angle L or A *n*, the measure thereof,
Is to the Sine of the Declination, *r o*, 10 d. 32 m.
So is the Radius or Sine of 90 d. 00 m.
To the Sine of the Amplitude 17 d. 3 m. L *o*, which is the distance of the Suns Rising or Setting, from the true East or West-points of the Horizon.

8. *The Latitude of the Place, and Declination of the Sun being given, to find the Ascentional Difference, or Time of his Rising and Setting.*

Suppose in the Latitude of 51 d. 32 m. the Declination, 10 d. 32 m. the Ascentional Difference is required.

In the right angled Triangle L *o r*, we have given *r o*, 10 d. 32 m. the Declination, and the Angle at L, the Compl. of the Latitude, 38 d. 28 m. to find L *r*, the Ascentional Difference.

As the Tangent Compl. of the Latitude 51 d. 32 m. the Angle at L, 38 d. 28 m.
Is to the Tangent of the Declination, *r o*, 10 d. 32 m.
So is Radius,
To the Sine of the Ascentional Difference, *r* L, 13 d. 32 m. the Ascentional Difference sought:

Which being converted into Time, by allowing 15 deg. to an hour, and one deg to four min. of Time, you will find it to be 54 min. of Time; which being substracted from six hours, there remains the 5 hours 6 min. the time of his Rising in Summer, or his Setting in Winter. Likewise if you add it to 6 hours, the Sum is 6 *h*. 54 min. the time of his Setting in Summer, or his Rising in Winter.

Some further Uses of the Lines of Hours and Azimuths, and Sines upon the Plane of the first Quadrant of the Back-side.

9. *Having the Latitude of the Place, and Declination of the Sun given, to find the Amplitude.*

Let the Latitude and Declination be as before; First then, Take 10 d. 32 m. the Declination, from the Line of Sines, and set one point of your Compasses on 90 d. 00 m. on the Azimuth-Line, and the other Point will rest at 17 d. 3 m. from 90 d. 00 m. or from the East or West either North or South, according as the Declination is; the Analogy of this you have in the first of the two last Proportions.

10. *The*

10. *The Latitude and Declination given, to find the Ascentional Difference.*

Let the Latitude and Declination be as before.

Lay the Thred of one Leg of the Sector on the day of the Month, which is inserted between the Hour-line and the Limb; or on the Declination on the Limb, and at the same time, the Thred will lie on the hour and minute of the Suns Rising, it being reckoned on the Morning-hours; or his Setting, being reckoned on the Afternoon-hours, which is at 5 h. 6 m. or 6 h. 54 m. likewise the Thred will lie on 13 d. 32 m. on the Azimuth-Line, the Ascentional Difference, it being numbred from 90 d. 00 m.

The Analogy for this is also laid down before.

11. *Having the Latitude and Declination of the Sun given, to find his Altitude, when he will be Dew-East or West.*

Take the Declination 10 d. 32 m. as before, out of the Line of Sines, and set one point on 90 d. in the Azimuth-Line; move the Thred of the Sector to the nearest Distance, and the Thred will cut 13 d. 30 m. on the Limb, it being numbered from 60 or 00 deg. which is the Altitude of the Sun when he is Dew-East or West; his Declination being 10 d. 32 m. North.

By

By the Artificial Sines.

As the Sine of the Latitude 51 d. 32 m.
Is to the Radius,
So is the sine of the Declination 10 d. 32 m.
To the Sine of 13 d. 30 m. the Altitude, as before.

12. *Having the Latitude of the Place, and Suns Declination and Altitude at East or West, to find the Time when he will be Dew-East or West.*

Take the Altitude before found, 13 d. 30 m. out of the Line of Sines, the Thred of the Sector being laid to the Declination 10 d. 32 m. counted from 60 d. or on the day of the Month; then setting one point of your Compasses with the Altitude on the hour-line; so that by turning the other about, may just touch the Thred, and the other point will stay at 5 h. 26 m. the hour from Noon.

By the Artificial Sines and Tangents.

As the Radius
Is to the Tangent of 10 d. 32 m. the Declination,
So is the Tangent-Compliment of the Latitude, 38 d. 28 m.
To the Sine of the Compliment of the hour from Noon, 8 d. 30 m.

Which

Which converted into Time, is 34 m. the Compl. thereof is 5 hours, 26 min. as before.

13. *The Latitude and Declination given, to find the Beginning and End of Twilight or Break of Day.*

Lay the Thred of the Sector on 10 d. 32 m. North Declination, counted from 60 or no deg. the contrary way, *viz.* when it is North Declination, lay it on the South; and when it is South, lay it on the North; then take 18 deg. from the Line of Sines for Twilight, or 13 deg. for Break of Day; then carry this distance along the Line of hours, on that side of the thred towards the beginning of the Hour-line, till by turning the other point about, may just touch the Thred; then shall the other point rest on 3 h. 32 m. for Break of Day: and if you take 18 deg. out of the line of sines, and apply the same way, you will find the point of the Compass to rest at 9 h. 6 m. of the small Figures or Morning hours for the end of Twilight.

14. *The Latitude and Declination given, to find the Altitude of the Sun at the Hour of Six.*

Lay the Thred on the Day of the Month, or Declination of the Sun 10 d. 32 m. Then take the nearest distance from the point of 6, and 6 on the hour-line, to the Thred; that distance applied on the Line of Sines, will reach from the beginning thereof, to 8 d. 4 m. the Suns Altitude

at

at six of the Clock; and thus the Altitude of the Sun at any hour of the day may be found.

The Thred being kept to the day of the Month, if from the Center at 12 in the hour-line, you open a pair of Compasses to touch the Thred at nearest distance, and apply the said extent to the Sines, you have the Suns Meridian Altitude; and if from each hour (and quarter if you please) in the said hour-line you take the nearest distances to the Thred still lying on the Day of the Month; and apply those Extents to the line of Sine, you shall have their respective Altitudes; and in many other Uses the Thred being laid to the Day of the Month, hath the same effect, as being laid to his Declination.

By the Sines.

As the Radius,
Is to the sine of the Suns Declination, 10 d. 32 m.
So is the sine of the Latitude 51 d. 32 m.
To the sine of 8d. 14 m. the alt. of 6, as before.

15. *The Latitude of the Place, and Altitude, and Declination of the Sun given, to find the hour of the Day.*

On the 10th. Day of *May* the Declination of the Sun is 20 d. 14 m. North, and Altitude 30 d. 00 m. in the Latitude of 51 d. 32 m. the hour of the Day is required.

Add the Compl. of the Latitude, and Compl. of

of the Altitude, and Compl. of the Declination together, and take the half Sum, then take the Difference between the half Sum and the Compl. of Altitude, thus;

Compl. Latitude	38 28
Compl. Altitude	60 00
Compl. Declination	69 46
Sum	168 14
Half Sum	84 07
Compl. Altitude	60 00
Difference	24 07

Then,

As the Radius,
Is to the sine Compl of the Latitude, 38 d. 28 m.
So is the sine of the Compl. of the Declination, 69 d. 46 m.
To a fourth sine, 35 d. 43.

Then say,

As the fourth sine, 35 d. 43 m.
Is to the sine of the half sum, 84 d. 07 m.
So is the sine of the Difference, 24 d. 07 m.
To a seventh sine 44 07.

Then the middle between the seventh sine 44 d. 07 m. and the sine of 90 d. falls at 56 d.

35 m. the Compliment of which being doubled, *viz.* 33 d. 25 m. is 66 d. 50 m. which being turned into Time, is 4 h. and 27 m. the Time from Noon required.

But becauſe this is ſomething troubleſome in finding the middle between the ſeventh ſine and the ſine of 90, the Circle of verſed ſines, which is deſcribed next within the ſines, will ſave that Trouble; for when the Thred of the Sector lies on the ſeventh ſine, it alſo lies on the verſed ſine of the hour required.

For if you lay the firſt Leg of the Sector on the ſine of 35 d. 43 m. the fourth ſine, and open the ſecond Leg to the ſine of 84 d. 7 m. the half Sum; then move the firſt Leg to the ſine of 24 d. 7 m. the Difference, the ſecond Leg will lie on the verſed ſine of 66 d. 50 m. as before.

16. *I will add another Example, and that ſhall be when the Sun hath South Declinat.*

Novemb. 25, the Declination of the Sun is 22° 30′ South, and obſerving the Altitude to be 10° 00′, in the Latitude of 51° 32′, add the Compl. Latitude, and Compl. Altitude, and the Diſtance of the Sun from the elevated Pole, together as before, and find the Sum and half Sum, and the Difference between the half Sum and Compl. of the Altitude, as before.

Compl. Latitude,	38° 28′,
Compl. Altitude,	80° 00′,
The Distance of the Sun from the Pole,	112° 30′,
The Sum,	230° 58′,
Half Sum	115° 29′,
Compl. Altitude substract.	80° 00′,
The Difference.	35° 29′,

Then say,

As the Radius,
Is to the sine of 38° 28′, the Compl. of the Latitude,
So is the sine of 112° 30′, the distance from Pole, or its Compl. to 180°,
To the sine of 35° 5′. a fourth sine.

Then,

As the sine of 35° 5′, the fourth sine,
Is to the sine of the half Sum, 115° 29′, or, 64° 31′, the Compl. to 180°,
So is the sine of the Difference, 35° 29′,
To the versed sine of 34° 32′.

Which being converted into Time, is 2 hours and 18 min. the hour from Noon required.

19. *The Latitude, and Altitude, and Declination of the Sun given, to find the Azimuth.*

Add the Compl. Latitude, Compl. Altitude, and the Distance of the Sun from the elevated Pole, as before, and find the Sum and half Sum, and the Difference between the half Sum, and the Compl. of Declination or Distance from the elevated Pole.

Let the Latitude, and Altitude and Declination be as followeth;

Compl. of the Latitude,	38° 28′,
Compl. Altitude,	70° 00′,
Compl. Declination, or Distance from the Pole,	80° 00′,
The Sum,	188° 28′,
Half Sum,	94° 14′,
The Compl. of the Declination,	80° 00′,
The Difference,	14° 14′,

Then,

As the Radius,
Is to the sine of 38° 28′, the Compl. of the Latitude,
So is the sine of 70° 00′, the Compl. of the Altitude,
To the sine of 35° 46′ a fourth sine.

Then,

Then,

As the ſine of the fourth Term, 35° 40′,
Is to the ſine of the half Sum, 94° 46′, or
85° 46′, its Compl. to 180°,
So is the ſine of the Difference, 14° 14′,
To the verſed ſine of 99° 16′, the Azimuth
from the North.

Which being ſubſtracted from 180° 00′, there remains 80° 44′, the Azimuth from the South, which was required.

18. *Again, when the Sun hath 10 d. 00 m. of South Declination, and the Latitude and Altitude as before.*

Compl. of the Latitude	38° 28′,
Compl. of the Altitude	70° 00′,
The Diſtance of the Sun from the North-Pole	100° 00′,
The Sum	208° 28′,
The half Sum,	104° 14′,
The Compl. Declin. or Diſtance from the Pole,	100° 00′,
The Difference,	4° 14′,

Then

Then,

As the Radius,
Is to the sine of 38° 28′, the Compl. of the Latitude,
So is the sine of 70° 00′, the Compl. of the Altitude.
To a fourth sine, 35° 46′.

Then,

As the Sine of the fourth Sine, 35 d. 46 m.
Is to the Sine of 114 d. 14 m. the half Sum, or 75 d. 46 m. the Compl. to 180.
So is the Sine of 4° 14′, the Difference.
To the versed Sine of 139° 3′, the Azimuth from the North.

Which being substracted from 180 d. there remains 40 d. 57 m. the Azim. from the South.

1. The

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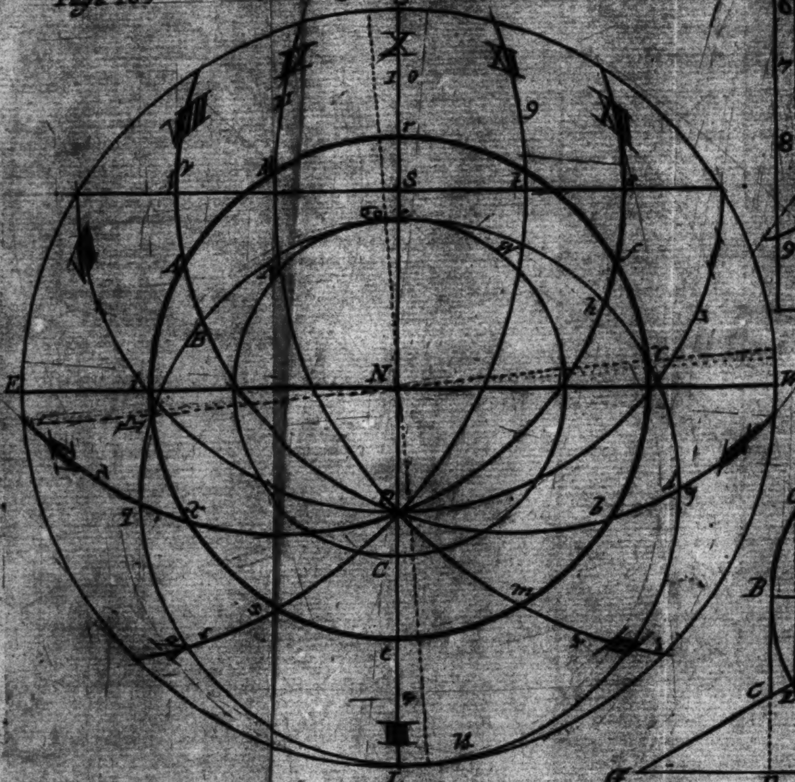
Figure the III



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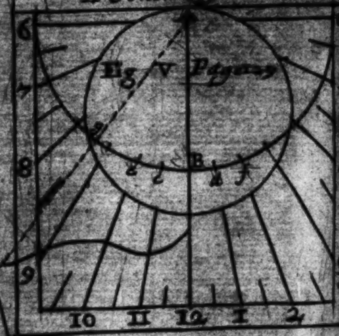

Figure the Ist

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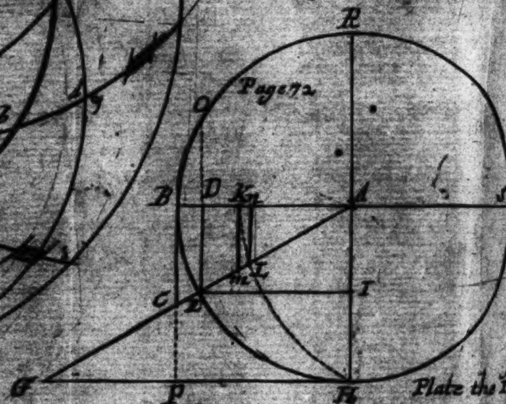

Plate the Ist

The Use of the Circles of Sines and Tangents,&c. in Astrology: *And first, how to set a Figure for any Hour and Minute of the Day or Night in any Latitude.*

1. LET it be required how to set a Figure the Third Day of *April*, at 4 hou. 18 m. past Meridian, *Anno* 1685, in the Latitude of 51 d. 32 m. the place of the Sun for that Day, is found by Mr. *Street*'s Tables, to be ♈ 23 d. 54 m. at Noon, and his right Ascension will be found 22 d. 15 m. by the 4th. Proposition; which converted into time, is 1 ho. 29 m. To which, if you add the 4 ho. 18 m P. M. it makes 5 ho. 47 min. the right Ascension of the Mid-Heaven, or 10th. House; or reduced into deg. is 86 d. 45 m.

Then after you have drawn the several Circles of Positions for the Cusps of the several Houses in *Fig.* 3. which is done in the manner following:

2. With 60 deg. of a Line of Chords describe the Circle ♈ r ♎ r, for the Equinoctial line; then take the half Tangent of 113 d. 45 m. in in your Compasses, and upon the same Center N, describe the Circle W O E ♑, for the Tropick of ♑, and with the half Tangent of 66 d. 30 m. describe the Circle ♋ C, for the Tropick of ♋, then

then set the half Tangent of the Latitude from N to P, which is here 51 d. 32 m. then take the Tangent of 38 d. 28 m. the compl. of the Latitude, and set it from N, to S; then set one point of your Compasses in S, and extend the other to R, and sweep the Circle 7 P 1, for the first and seventh houses; then through the point S, draw a line parallel to W E; for in this Line the Centers of the other Houses are found, by making S N a Radius, and so the Tangents of 30, and 60, set both ways from S, shall be the Centers for the describing of the other Houses.

And thus having described the several Houses, and set Figures thereto; the next thing will be to describe the Ecliptick, according to the time of the Question; and that is thus;

Having found the right Ascension of the 10th. House, as before, to be 86 d. 45 m. which being taken from the same Line of Chords, and set from the 10th. House at r, upon the Equinoctial, as ♈, which is the Point where the Ecliptick crosses the Equinoctial at the first Point of *Aries*; so that if a Line be drawn from *Aries*, through the Center N, where that Line crosses the Equinoctial on the other side, shall represent the first Point of *Libra*: Then draw the Line ♋ N ♑, at right Angles to the other, *viz.* ♈ N ♎, the Center to sweep the Ecliptick, will be in the middle, between ♋ and ♑.

And thus having been brief in the projecting of this Figure, I come now to resolve the several Triangles thereof, which is composed of Arches of the Equinoctial Ecliptick, and Circles of

Positions,

Positions: And first, To find the Cusp of the 10th. House, or the Point of the Ecliptick at *e*.

3. In the right angled Triangle ♈ *r e*, right angled at *r*, we have given ♈ *r*, the right Ascension of *M. C.* 86 d. 45 m. and the Angle at *Aries*, the greatest Declination of the Sun, or Obliquity of the Ecliptick, to find *Aries*, *e*, the Cusp of the *M. C.*

Then,

As the Radius,
Is to the Sine Compl. of the Angle at *Aries*, 66 d. 30 m.
So is the Tangent Compl. of *Aries*, *r*, 3 d. 15 m.
To the Tangent Compl. of *Aries*, *e*, 3 d. 00 m.

Which being substracted from 90 d. there rests 87 d. 0 m. for *Aries*, *e*, which is two Signs, 27 d. 00 m. that is, *Gemini*, 27 d. 00 m. for the Cusp of the 10th. House, or *M. C.*

For the Cusp of the Ascendent.

4. In the oblique angled Triangle ♎, *g*, *i*, we have given the Angle at ♎, 23 d. 30 m. the greatest Obliquity of the Ecliptick; and the Angle at *i*, 38 d. 28 m. the Compl. of the Latitude, with the side ♎ *i*, 33 d. 15 m. the Compl. of the oblique Ascension of the Ascendent to 180; which is found (thus;)

To the right Ascension of the 10th. House, 86 d. 45 m. add 90 d. 00 m. the sum is 176 d

45 m. the oblique Ascension of the Ascendent; which being substracted from 180, there remains 3 d. 15 m. for ♎ i, we are to find ♎ g, the distance between the first Point of *Libra*, and the Cusp of the Ascendent, at *g*.

Then say,

As the Radius,
Is to the Tangent of the Angle at *i*, 38° 28′,
So is the sine-compl. of *i* ♎ 3 d. 15 m. *viz.* 86 d. 45 m.
To the Tangent of an Arch, 52 d. 29 m.

From which substract the Angle at *Libra*, 23 d. 30 m. the Remainer is 28 d. 59 m.

Then,

As the sine compl. of 52 d. 29 m. the Arch last found,
Is to the sine compl. of the Remainer, 28 d. 59 m.
So is the Tangent compl. of ♎ *i*, 3 d. 15 m.
To the Tangent compl. of ♎ *g*, 2 d. 13 m.

Which is ♍, 27 d. 47 m. for the Cusp of the Ascendent.

Then for the Cusps of the other Houses.

5. First, we are to find the Angles that the Circles of Positions of the several Houses make with the Equinoctial; which Angle is the Comp. of the height of the Pole above those Circles to 180 d.

180 d. so that if we find two of those Angles, we find all the others.

First then,

In the right angled Spherical Triangle, p, t, x, right angled at t, we have given p t, the comp. of the Latitude; and the side t x, 60 d. 00 m. which is found thus;

To the oblique Ascension of the Ascendent, 176 d. 45 m. add 30 d. 00 m. the sum is 206 d. 45 m. the oblique Ascension of the second house; which being substracted from the right Ascension of the fourth House at t, 266 d. 45 m. there remains 60 d. 00 min. equal to t x, as before; then to find the Angle at x, say,

As the Radius,
Is to the Tangent compl. of p t, 38 d. 28 m. the compl. of the Latitude,
So is the sine of t x, 60 d. 00 m. the difference of Ascensions,
To the Tangent compl. of the Angle at x, 42 d. 32 m.
Which is equal to the Angles at 6 b and A, that is, the 6th, 8th, and 12th. Houses.

Then in the Triangle p, t, z.

6. We have given the side p t, 38 d. 28 m. as before, the compl. of the Latitude, and the side t z, 30 d. 00 m. which is found by adding 30 d. 00 m. to the oblique Ascension of the Point x, or second House, 206 d. 45 m. the sum is 236 d. 45 m. Which being substracted from 266 d. 45′, the

the right Ascension of the Point r, or fourth House, there remains 30 d. 00 m. t z, as before.

Then,

As the Radius,
Is to the Tangent compl. of the Latitude 38° 28 m. p t,
So is the Sine of t z, 30 d. the difference of Ascension,
To the Tangent compl. of the Angle at z, 57 d. 49.
Which is equal to the Angles at m k and M, or the 5th. 9th. and 11th. Houses.

To find the Cusp of the Second House.

7. In the oblique angled Triangle ♎ x q, we have given the Angle at x, 42 d. 32 m. before found, and the Angle at *Libra*, 23 d. 30 m. the Obliquity of the Ecliptick, with the side ♎ x, 26 d. 45 m. for if we substract ♎, i, 3° 15′, before found, by the oblique Ascension of the Ascendent, from i, x, 30 d. 00. there will remain *Libra*, x, 26 d. 45, as before; then to find the side *Libra*, q, the Point of the Ecliptick, upon the second House.

As the Radius,
Is to the Tangent of the Angle at x, 42 d. 32 m.
So is the sine compl. of *Libra*, x, 26 d. 45 m.
To the Tangent compl. of an Arch, 50 d. 40 m.

From

From which Arch substract 23 d. 30 m. the Angle at *Libra*, there remains 27 d. 10 m.

Then say,

As the sine compl. of 50 d. 40 m. the aforesaid Arch.
Is to the sine compl. of 27 d. 10 m, the difference between 50 d. 40 m. and 23 d. 30 m.
So is the Tangent comp. of *Libra*, *x*, 26 d. 45 m.
To the Tangent compl. of *Libra*, *q*, 19 d. 45 m.
Which is *Libra*, 19 d. 45 m. for the Cusp of the second House.

For the Cusp of the Third House.

8. To *Libra*, *x*, 26 d. 40 m. add 30 d. *x*, *z*, the sum is *Libra*, *z*, 56 d. 40 m. we have also given the Angle at *z*, 57 d. 49 m. the Compl. of the height of the Pole, above that Circle of Position before found, with the Angle at *Libra*, 23 d. 30 m. as before.

To find *Libra*, *a*, the Cusp of the Third House.

As the Radius,
Is to the Tangent of the Angle at *z*, 57 d. 49 m.
So is the Sine compl. of *Libra*, *z*, 56 d. 40 m.
To the Tangent comp. of an Arch, 48 d. 53′.
From which substract the Angle at *Libra*, there remains 25 d. 23 m.

Then

Then,

As the Sine compl. of the aforesaid Arch, 48 d. 53 m.
Is to the Sine compl. of the last Remainer, 25 d. 23 m.
So is the Tangent compl. of *Libra*, z, 56 d. 40 m.
To the Tangent compl. of *Libra*, a, 47 d 52′.

From which substract 30 deg. there remains 17 d. 52 m. which is ♏, 17 d. 52 m. for the Cusp of the Third House.

For the Cusp of the Twelfth House.

9. In the Triangle *Libra*, A B, we have given *Libra*, A, 33 d. 15 m. the difference between the oblique Ascension of the Ascendent, and oblique Ascension of the 12th. House, more by *Libra*, *i*, 3 d. 15 m. and likewise the Angle at A, 42 d. 32 m. equal to the Angle at *x*, with the Angle at *Libra*, 23 d. 30 m. to find *Libra*, B, the Cusp of the Twelfth House.

As the Radius,
Is to the Tangent of the Angle at A, 42 d. 32 m.
So is the Sine Complement of *Libra*, A, 33 d. 15 m.
To the Tangent compl. of an Arch, 52 d 31′.

From which 52 d. 31 m. substract 23 d. 30 m. the Angle at *Libra*, and there remains 29° 1′

Then

Then say,

As the Sine compl. of 52 d. 31 m. the aforesaid Arch,
Is to the Sine compl. of the Remainer, 29° 1',
So is the Tangent compl. of *Libra*, A, 33 d. 15 m.
To the Tangent compl. of *Libra*, B, 24 d. 19 m.

Which being substracted from 30 d. because it wants so much of the first Point of *Libra*, there remains ♍, 5 d. 41 m. for the Cusp of the Twelfth House.

For the Cusp of the Eleventh House.

10. In the Oblique angled Triangle *Libra*, M, N, we have given *Libra*, M, 63 d. 15 m. by adding 30 d. 00 m. to *Libra*, B, 33 d. 15 m. and the Angle at M, 57 d. 49 m. equal to that at *z*, with the Angle at *Libra*, 23 d. 30 m. as before, to find *Libra* N, the Cusp of the Eleventh House.

As the Radius,
Is to the Tangent of 57 d. 49 m. the Angle M,
So is the Sine compl. *Libra*, M, 63 d. 15 m.
To the Tangent compl. of any Arch, 54° 26'.

From which substract the Angle at *Libra*, 23 d. 30 m. the Remainer is 30 d. 56 m. for the second Arch.

Then,

Then,

As the Sine compl. of the first Arch, 54 d. 26 m.
Is to the Sine compl. of the second Arch, 30 d. 56 m.
So is the Tangent compl. of *Libra*, M, 63 d. 15.
To the Tangent compl. of *Libra*, N, 53 d. 23 m. the distance of the Cusp of the Eleventh House from the first Point of ♎.

Which being substracted from 60 d. 00 m. there remains 6 d. 37 m. of ♌, for the Cusp of the Eleventh House.

Thus having found the Cusps of the six Oriental Houses, the six Occidental are also found; for opposite Houses give opposite Sines, and the same Degrees.

For the Triangles *Aries v m*, *Aries d b*, *Aries g f*, *Aries w k*, are equal to *Libra z a*, *Libra x q*, *Libra* A B, *Libra* N M; so that it is all one which of those Triangles you resolve, so that by this Method you may calculate the Cusps of the Houses in any Latitude, and for any Hour of the Day.

Note, That when the Angles at *x* and *z*, are obtuse, that is above 90 d. 00 m. or which is all one, when the Sides *Libra q*, and *Libra a*, is greater than the Side *Libra x*, *Libra z*, then you must add the first Arch found, to the Angle at *Libra*, 23 d. 30 m. and the Sum shall be the

the ſecond Arch ; and then work in every reſpect as before. Proceed we now to the finding the Arch of Directions in any Nativity.

1. *To find the Diſtance of a Star or Planet from the Meridian in Right Aſcenſion.*

If a Star or Planet be between the Tenth Houſe and the Aſcendent, or between the fourth Houſe and the ſeventh, you muſt ſubſtract the right Aſcenſion of the Tenth or Fourth from the right Aſcenſion of the Planet or Star, and the Remainer is the diſtance from the Meridian; but if the Star be between the *M. C.* and Seventh or Fourth, and the Aſcendent, then ſubſtract the right Aſcenſion of the Star from the right Aſcenſion of the M. C. or I. C. the Remainer is the diſtance from the Meridian.

Let the right Aſcenſion of the M. C. be 86 d. 45 m. as before, and ſuppoſe a Planet be in the Eighth Houſe, having right Aſcenſion 23 d. 47, his diſtance from the Meridian will be found to be 62 d. 58 m.

2. *How to find the Height of the Pole above any Planets Circle of Poſition, commonly called the Pole of Poſition.*

First find the right Aſcenſion of the M. C. and alſo the Planets right Aſcenſion and Declination, and by that, his diſtance from the Meridian, as before.

As for Example.

Let the right Ascension of the M. C. be 86 d. 45 m. as before; and suppose a Planet posited in the 8th. House, with right Ascension 23 d. 47 m. his distance from the Meridian, will be 62 d. 58 m. and Declination North, 9 d. 42 m.

In the Oblique angled Triangle, *p n* ☿, we have given *p n*, the Latitude of the place; which in this Example is 51 d. 32 m. and the side *p* ☿, the Compl. of the Declination 80 d. 18 m. with the Angle at *p*, 117 d. 2 m. the compl. of *n k*, the distance of the Planet from the Meridian to 180 d. equal to the outward Angle at *p*, 62 d. 58 m. to find first the Angle at ☿.

As the Radius,
Is to the Tangent of *p n*, 51 d. 32 m. the Latitude,
So is the Sine compl. of the outward Angle at *p*, 62 d. 58 m.
To the Tangent of *p q*, 29 d. 46 m.

To which add *p* ☿, 80 d. 18 m. the Sum is 110 d. 4 m. ☿ *q*.

Then say,

As the sine of *p q*, 29 d. 46 m.
Is to the sine of ☿ *q*, 110 d. 4 m. or its compl. to 180 d. *viz.* 69 d. 56 m.
So is the Tang. compl. of 62 d. 58 m. the outward Angle at *p*.
To the Tang. compl. of the Ang. at ☿, 40 d. 7.

Then

Figure the IIII

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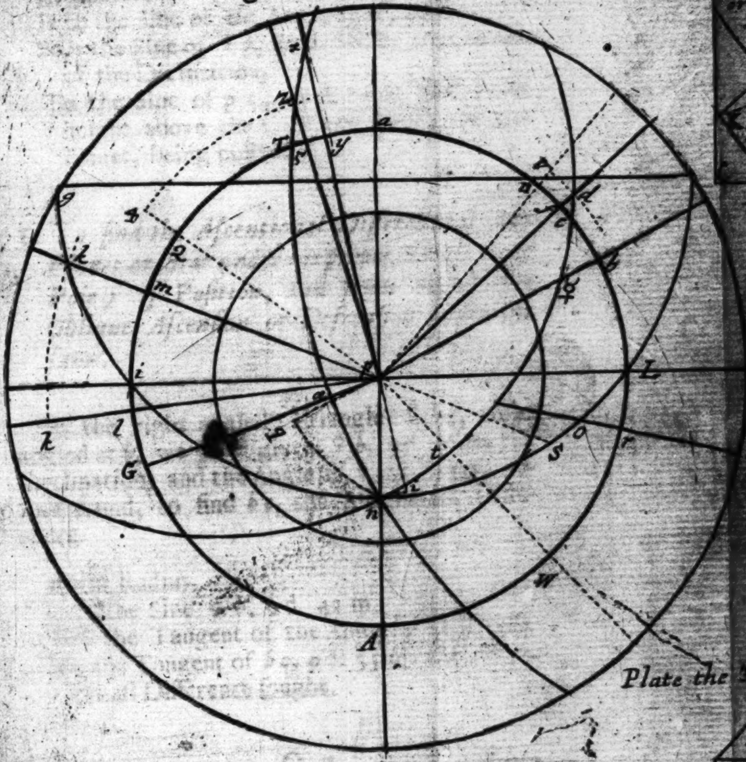
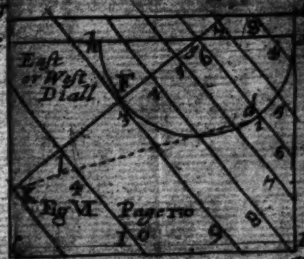




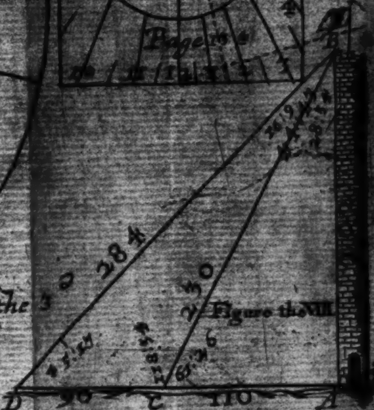
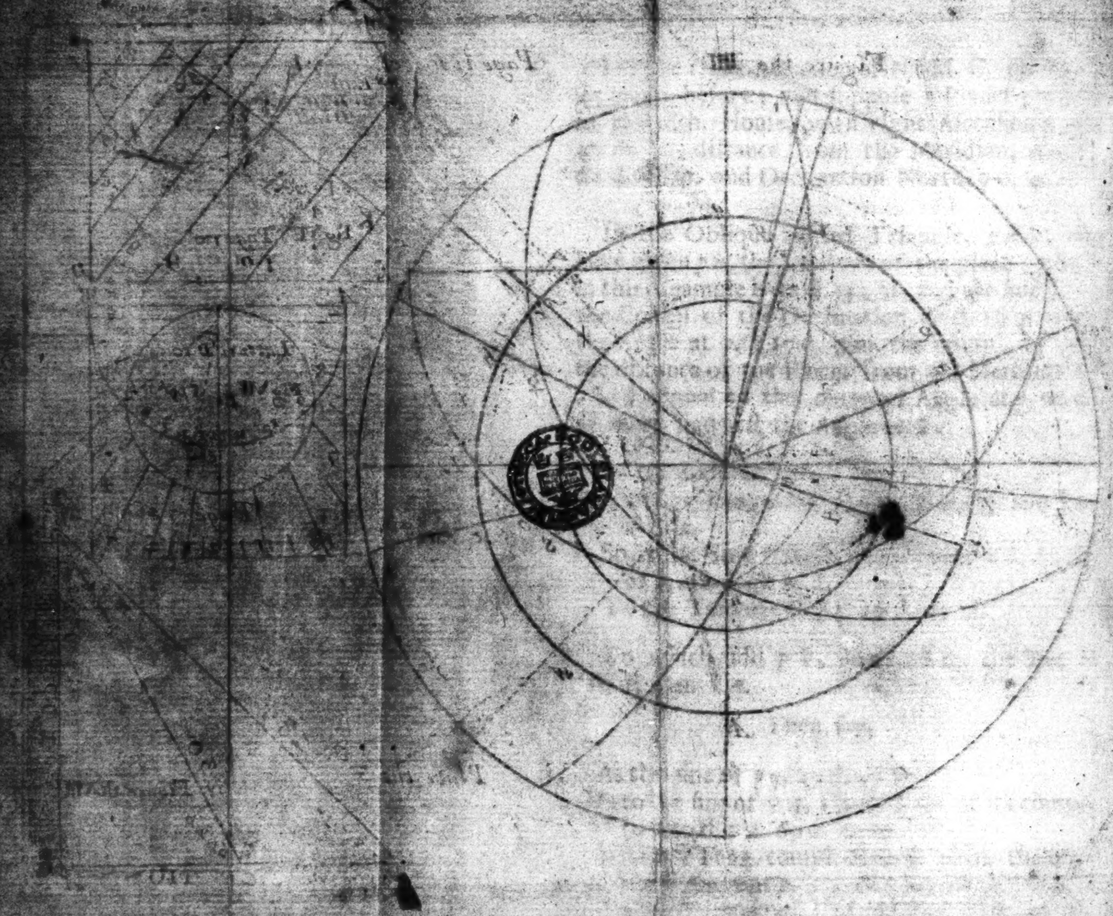


Plate the 3



Then for p t, the Height of the Pole.

As Radius,
Is to the Sine of the Angle at ☿, 46 d. 15 m.
So is the Sine of ☿ *p*, 80 d. 18 m. the Compl. of the Declination,
To the Sine of *p t*, 45 d. 14 m. the Poles height above the Circle of Position of the Planet, being posited at ☿.

3. *To find the Ascentional Difference of any Planet or Star under his proper Circle (or Pole) of Position, and from thence his Oblique Ascension or Descension under the same.*

In the right angled Triangle ☿ *b c*, right angled at *b*, we have given ☿ *b*, 9 d. 42 m. the Declination, and the Angle at ☿, 46 d. 5 m. before found, to find *b c*, the Ascensional Difference.

As the Radius,
Is to the Sine ☿ *b*, 9 d. 42 m.
So is the Tangent of the Angle ☿ 46 d. 5 m.
To the Tangent of *b c*, 9 d. 55 m. the Ascentional Difference sought.

Then for the Oblique Ascension or Descension.

According to the Rule in the Fifth *Problem* of the Third Chapter of the First Part, add the Ascentional Difference *b c*, 9 d. 55 m. to the right Ascension of the Point *b*, that is, the right Ascension of the Planet at ♉, 23 d. 47 m. the Sum is 33 d. 42 m. the Oblique Descension.

And thus, according to these Rules, you may find the Pole of Position, Ascentional Difference, and Oblique Descension, and Ascension of any Planet or Star with or without Latitude.

How to direct a Significator to its Promitor

And first, *To direct the M. C. to its Promitor, is thus*;

First, Find the right Ascension of the M. C. and the right Ascension of the Promitor, and substract one from the other, the Remainer is the Arch of Directions.

For Example.

Let the right Ascension of the M. C. be 86 d. 45 m. as before; and let the right Ascension of the Promitor be 112 d. 45 m. the Arch of Directions will be 26 d. 00 m.

4. *To*

4. *To direct the Ascendent to its Promitor.*

Before we can direct a Significator to his Promitor, we must first find the height of the Pole above the Significators Circle of Position, which in the M. C. is nothing at all, because the Pole it self lies in the Meridian, and so hath no Elevation above it; but in the Ascendent and 7th. House, it is always equal to the Latitude of the place of Birth, that is in our Latitude, 51 d. 32 m. but in all other places of the Heavens different: The Method for finding it, is already shewed.

Then to proceed,

Let the Ascendent be directed to a Promitor, posited at *h*, with right Ascension, 117 d. 45 m. and Declination 16 d. South.

In the right angled Triangle, *p k n*, we have given *p n*, 51 d. 32 m. the Latitude of the Place, with the side *p k*, 106, the distance of the Promitor from the North-Pole, to find the Angle at *p*.

But first, it will be necessary to find the Promitors distance from the Meridian, or I. C. that is, *l* A, which will be found by the Rules foregoing, to be 79 d. 00 m. for the distance from the Meridian, that is, *l* A.

As the Radius,
Is to the Tangent of *p n*, 51 d. 32 m.
So is the Tangent compl. of *p k*, 106, or 74, its compl. to 180 d.
To the Sine compl. of the Angle *p*. 68 d. 50 m.

Which

Which being substracted from 180 d. leaves 111 d. 10 m. (because the Angle at *p*, is obtuse) which is equal to A *m*, from which substract A *l*, 73, there remains *l m*, 32 d. 10 m. for the Arch of Directions.

But if any one think this Triangle troublesome to resolve, because the sides and angle at *p*, is above 90 deg. they may resolve the Triangle *p*, *n*, S, which is the Compliment of the other to 180 d. 00 m. for the Proportion is the very same as before; for the Tangent compl. of *p k*, to 180 d. is really the Side *p* S, and the Angle which is found, is the Angle at *p*, in the Triangle *p n* S; which being substracted from 180 d. leaves the Angle *p*, equal to the Arch A *m*, &c.

5. *How to direct a Significator posited in the descending part of Heaven, to its Promiter.*

Suppose a Promiter to be placed at ♀, having right Ascension, 23 d. 47 m. and Declination, 9 d. 42 m. North, to be directed to a Star or Planet at *v*, with right Ascension, 46 d. 00 m. and Declination 5 d. 00 m. South.

Having found the Pole of Position of the Significator before, to be 45 d. 0 m. we proceed to find the Ascentional Difference of the Promiter under the Significators Circle of Position.

In the Triangle *d f c*, right angled at *f*, we have given *d f*, the Declination of the Promiter, 5 d. 00 m. with the Angle at C, 44 d. 40 m. the compl. of the Pole of Position of the Significator, to find *f c*, the Ascensional Difference.

As

As the Radius,
Is to the Tangent of *d f*, 5 d. 00 m. the Declination,
So is the Tangent compl. of the Angle at C, 44 d. 46 m.
To the Sine of C *f*, 5 d. 7 m. the Ascensional Difference sought.

Which being added to 33 d. 2. the Oblique Ascension of the Significator, *c*, their Sum is, 38 d. 5 m. the right Ascension of the Point *f*, which being substracted from the right Ascension of the Promiter at *n*, 46 d. 00 m. there remains *f n*, 7 d. 55 m. the Arch of Directions required.

A Significator may be directed to a Promiter, another way; as thus:
In the Triangle *p* ☿ *n*, we have given *p* ☿, 80 d. 18 m. the Compl. of the Declination of the Significator, as before.

And *p n*, the Latitude of the Place, 51 d. 32′, with the Angle at *p*, 117 d. 2 m. the Compl. of the Significators distance from the Meridian, *viz*. *b a*, to find the Angle at ☿.

As the Radius,
Is to the Tangent of *p n*, 51 d. 32,
So is the Sine compl. of 62 d. 58 m. the distance from the Meridian, *a b*,
Equal to the outward Angle at *p*,
To the Tangent of *q p*, 29 d. 47 m.

Then

Then,

As the Sine of *pq* 29 d. 46.
Is to the Sine of ☿ *pq*, 110 d. 4 m. (which is found by adding *pq*, 29 d. 46 m. to *p*, *Mercury*, 8 d. 18 m.) or its Compl. to 180°, *viz*. 69 d. 46 m.
So is the Tangent compl. of 62 d. 58 m. the outward Angle at *p*,
To the Tangent compl. of the Angle at *Mercury*, 46 d. 00 m.

Then to find p t, the height of the Pole above the Circle of Position of the Significator.

As the Radius,
Is to the Sine of the Angle at *Mercury*, 46° 00′,
So is the Sine of *Mercury p*, 80° 18′. the comp. of the Significators Declination,
To the Sine of *p t*, 45 d. 9 m. the Pole of Position required.

Thus far is the same as before.

Then in the Triangle *p t Mercury*, right angled at *t*, we have given *p Mercury* 80 d. 18 m. as before, with the Angle at *Mercury*, 46 d. 00 m. to find the Angle at *p*, or the Arch W *b*.

As

As the Radius,
Is to the Tangent of the Angle at *Mercury*, 46 d. 00 m.
So is the sine compl. of p *Mercury* 80 d. 18 m.
To the Tangent compl. of the Angle at p. 80 d. 43 m. or the Arch W *b*.

Which being substracted from the right Ascension of the Significator, 23 d. 47 m. at *b*, by adding 360 d. that so Substraction may be made, and there remains 303 d. 04 m. for the right Ascension of the point W.

Again,

In the right angled Triangle *p t d*, right angled at *t*, we have given *p d*, the distance of the Promitor from the North pole, 95 d. 00 m. because he had 5 d. 00 m. of South-Declination, *viz. f d*, and the Side *p t*, 45 d. 9 m. the Pole of Position of the Significator, to find the Angle at *p*, or the Arch *f* W.

As the Radius,
Is to the Tangent of *p t*, 45 d. 9 m.
So is the Tang. compl. of *p d*, 95 d. 00 m. or 85 d. its Compl. to 180 d.
To the Sine compl. of the Angle *p*. 84 d. 58 d. which 84 d. 58 m. is the Compl. of the angle at *p*, to 180 d. or the Arch W *f*, *viz.* 95 d. 2 m.

Which being added to 303 d. 4 m. the Sum is 398 d. 06 m. from which substract the Circle 360 d. there remains 38 d. 6 m. for the the right Ascension of the point *f*; which

S sub-

substracted from the right Ascension of the Promitor at *n viz.* 46 d. 00 m. there remains *n f*, 8 d. 54 m. the Arch of Directions, as before, to a Minute.

So that by either of these two ways may be found the arch of Directions very exactly; the Reader being left to use that which likes him best; or if you please to use both ways, and so the one to confirm the other.

Again,

Suppose a Significator be between the Ascendent and *M.C.* posited at *x*, having right ascension, 98 d. 31 m. and Declination 18 d. 46 m. South, which is to be directed to a Promitor at ♃, with right ascension 140 d. 10 m. and Declination South, 8 d. 9 m. the arch of Directions, Q 5 d. is required.

Then,

First, Through the Points *n* and *x*, draw the Circle of Position of the Significator, *n z x*, likewise draw *p x*, through the point *y*, for the Significators right ascension: likewise draw *p* ♃, through the point Q, for the Promitors right ascension; and likewise *p z* through the point W d. his right ascension, when he comes to touch the Significators Circle of Position.

Then,

In the oblique angled Spherical Triangle, *n p x*, we have given *p n*, 51 d. 32 m. the Latitude

Latitude of the Place, and *p x*, the distance of the Significator from the North-pole, with the angle at *p*, 168 d. 14 m. the compl. of the Significator from the Meridian or *M. C.* or rather the outward angle at *p*, 11 d. 46 m. the distance from the *M. C.* to find first the Angle at *x*.

As the Radius,
Is to the Tangent *pn*, 51 d. 32 m.
So is the sine-compl. of 11 d. 46 m. the distance from the *M. C.*
To the Tangent of 50 d. 56 m. *viz.* I. P.
Which being added to *x p*, 108 d. 46 m. then the Sum is X I, 159 d. 42. m.

Then,

As the sine of *p* I 50 d. 56 min.
Is to the sine of 159 d. 42 m. *x* I, or 20 d. 18 m. the compl. to 180.
So is the Tangent compl. of the Angle *p*, 11 d. 46 m.
To the Tangent compl. of the Angle at *x*, 21 d. 00 d.

Then for p x, the height of the Pole above the Circle of Position.

As the Radius,
Is to the Sine of the Angle at *x* 25 d. 00 m.
So is the Sine of *p x* 108 d. 46 m. or 71 d. 14 m. the Compl. thereof to 180 d.
To the Sine of *p x*, 23 d. 35 m. the Poles height above the Significators Circle of Position.

For the Angle at p, that is x p a.

As the Radius,
Is to the Tangent of 25 d. 00 m. the Angle at *x*,
So is the Sine compl. of *p x*, 108 d. 46 m. or 71 d. 14 m.
To the Tangent compl. of 81 d. 28 m.

Which being substracted from 180 d. there remains 98 d. 32 m. for the angle *x p a*.

The Reason why the Arch so found is substracted from 180 d. is, because the Side opposite to the Angle sought, is above 90 d. therefore the Angle will be above 90 d. also; the quantity of which angle is found by substracting the Arch found from 180, and the Remainer is the angle required.

Then

Then in the right angled Triangle x p a,

We have given z p, 98 d. 9 m. the distance of the Promitor from the North-pole, when he comes to touch the Circle of Position of the Significator with p a, 23 d. 35 m. the Pole of Position of the Significator; to find the Angle z p a.

As the Radius,
Is to the Tangent of p a, 23 d. 35 m.
So is the Tangent compl. of p z, 98 d. 9 m. or 81 d. 51 m. the compl. thereof to 180°.
To the sine compl. of 86 d. 24 m.

Which being substracted from 180 d. there remains 93 d. 36 m. for the Angle z p a.

Then,

If you add the Angle x p a, 98 d. 32 m. before found, to 98 d. 31 m. the right ascension of the Significator at y, the Sum is 197° 03′, the right ascension of the Point G, then substract the Angle z p a, 93 d. 36 m. last found, from the right ascension of the Point G, 197 d. 03 m. there remains 103 d. 24 m. for the right ascension of the Point 5, that being substracted from the right ascension of the Promiter at Q, 140 d. 10 m. there remains 5, Q, 36 d. 46 m. for the Arch of Directions.

How

How to rectifie a Nativity.

THE Rectification of a Nativity is very easie, if you consider what hath been said in the Directions; as thus:

If you have an Accident of Note compared with the *M. C.* or Ascendent, it is but only to direct the *M. C.* or Ascendent to the Significator, which denotes the Accident, as before; and if you find not the Acch to agree with the Accident, according to your measure of Time, then you must substract the right Ascension of *M. C.* or oblique Ascension of the Ascendent, from the right Ascension of the Promitor (for the *M. C.*) or oblique Ascension of the Promitor (for the Ascendent) by adding 360 deg. when Substraction cannot be made, and the Remainer is the right Ascension of the *M. C.* or oblique Ascension of the Ascendent truly rectified.

But to rectifie by the Sun or Moon, you must find the height of the Pole above their Circles of Position, which is first done by estimation, and by the supposed Pole of Position, the true Pole is found in this manner;

Your Figure being erected for the supposed Time of Birth, you may estimate very near the Pole of Position of the Sun or Moon, by their Place in the Figure; as if in the Latitude of 51 d. 32 m. if the Sun or Moon be in the 12th. 6th. Ascendent, or 7th. Houses, then the Pole of Position is between 51 d. 32 m. and 47 d. 28 m. and if in the 11th. 2d. 5th. and 8th. Houses, the Pole is between 47 d. 28 m. and 32 d. 11 m. if in the 10th. 9th. 3d. 4th, Houses,

House, the pole is between 32 d. 11 m. and 00 d. 00 m. so that by the distance from the Cusps of those Houses, you may estimat very near the pole proper to their place in the Figure, you may direct him to the most significant Promitor under his Pole, and so find the Arch of Direction, noting the Difference between it and the time of the Accident given.

Then estimate the second time, as before, and find that Arch; then take the Difference between the two Arches of Directions, and by the Rule of Three, say,

As the Difference between these two Arches,
Is to the Difference of the pole of position which was estimated,
So is the Difference between the true Arch, and the nearest of the two before found.
To the true Pole of position, and from thence the oblique Ascension or Descension, and Distance from the Meridian, and consequently the right Ascension of the *M.C.* truly found, *&c.*

The Use of the Circles of Numbers, Sines and Tangents in Dyalling.

SUn-Dials may be made upon any Plain whatsoever; that is, either Horizontal, Direct, Declining, reclining, or Inclining.

Horizontal Plains are those which lie parallel to the Horizon.

Direct

Direct Plains are those which behold the four Cardinal points and cut the Horizon at right Angles, *viz.* North, South, East or West.

Declining Plains are those that behold not the aforesaid Points, but decline from the North or South towards the East or West.

Reclining Plains are those that behold the Zenith, as the outside of the Roof of a House.

Inclining behold the Nadir (opposite to the Recliners) represented by the inside of the Roof of a House.

In the Horizontal and Direct Plains there is nothing required but the Latitude of the place, which is alwayes equal to the height of the Style in a Horizontal Dyal.

In the North and South Plains the height of the Style is always equal to the compl. of the Latitude.

In East and West Dials the Pole hath no elevation above them, the Hour-lines being all parallel one to another, and may be drawn nearer or further asunder, according as you augment the height of the Style: So in any of these Dials there is nothing more to be calculated but the hours distance from the Substyle. To find which, the proportion is, first for all plain Dials that have Centers.

As the Radius,
Is to the Sine of the Styles height,
So is the Tangent of each hours distance from
the Substyle upon the Equinoctial.
To the Tangent of the same hours distance
From the Substyle upon the Plain.

To

To do which, prepare a Table of three Columns; in the firſt of which ſet the Hours as they are diſtant from the Subſtyle: In the ſecond Column ſet the Equinoctial diſtance belonging to each Hours diſtance from the Subſtyle, which is 15 deg. to each Hour: And in the third Column ſet the Arches (found by the laſt Proportion) over againſt their reſpective Hours.

An Example of a South and North-Dyal, in the Latitude of London, 51 *deg.* 32 *min.*

Firſt then, in the Table following ſet down the Hours in their order from 12, both for the Forenoon and Afternoon; as 11 and 1, 10 and 2, 9 and 3, *&c.* and the half hours and Quarters if you pleaſe; which here is done only to half hours: Then in the ſecond Column ſet the Equinoctial diſtance belonging to each hour-diſtance from 12, over againſt their reſpective hours; as againſt half an hour after 11, or 12, ſet 7° 30′ and againſt 11, and 1, ſet 15°; and half an hour after 10, or half an hour after 1, ſet 22° 30′, which is the di-

Hou. before and after N.	*Hou. diſtance on the Equ.*	*True H. diſt. on the Pla.*
	° ′	° ′
12	00 00	00 00
½	07 30	04 41
11 01	15 00	09 28
½	22 30	14 27
10 02	30 00	19 45
½	37 30	25 31
09 03	45 00	31 53
½	52 30	39 02
08 04	60 00	47 08
½	67 30	56 20
07 05	75 00	66 42
½	82 30	78 03
6	90 00	90 00

stance of those Hours from 12, upon the Equinoctial; and so of the rest, as in the Table, by adding 15° 00′ for each hour, and 7° 30′ for every half hour, &c.

Then for the true hours distance on the Plain,

As the Radius or Sine of 90° 00′,
Is to the Sine Compl. of Latitude 38° 28′, the height of the Style,
So is the Tangent of 07° 30′, the Equinoctial distance for half an hour from 12.
To the Tangent of 4° 41′, the true hours distance; and so is the Tangent of 15° 00′, the Equinoctial distance for 11; and 1, to the Tangent of 9° 28′, the true hours distance for the said hours.

And so is the Tangent of any other number of Degrees and Minutes in the second Column, to the Tangent of their respective hours, as in the Table, &c.

Then for the making of the Dial, *Fig.* V.
First, Draw the perpendicular Line A B, for the hour of 12, and cross it at right Angles for the hour of 6 and 6; then take 60 deg. of a Line of Chords, and upon A, as a Center, describe the Semicircle 6 B 6; which done, take 4° 41′ for half an hour after 12, out of your Line of Chords, and set from B, upon the Semicircle both ways to *c*, and *d*; then take 9, 28 for 1, and 11, and set from B, as before, to *e*, and *f*; and so of the rest, as in the Table: And then if you draw straight Lines from the Center A, through each point on the Semicircle for each hour; as, A *c*, A *d*, A *e*, A *f*, and

and they ſhall be the true hour-lines for the ſaid Dial.

Then for the Style.

Take 38° 28′, out of your Line of Chords, and ſet from B, to *g*, then draw a Line from A, to *g*, for the Style; which being made of a plate of Iron, or other Metal, or elſe a piece of Wyer, bent to the Angle 38° 28′, and ſet perpendicularly over the Subſtyle, which is the hour-line of 12, it ſhall ſhew the true hour of the Day, it being ſet againſt a South-wall.

In the making of a North-Dial, the ſame hour-diſtances as in a South, effect it, being drawn through the Center, and needs no Example; only in the South-Dial the Center is at the Top of the Plain, but in the North, it muſt be in the middle of the Plaine; and the Cock muſt point upwards in this, as it doth downward in the other.

To make an Eaſt, or Weſt Dial. Fig. VI.

FIrſt, having prepared your Plane, on which you intend to draw your Dial, as A B C D, you muſt draw an horizontal line near the upper Edge thereof, as *f*, *e*, and divide the ſame into three equal parts; then count one of thoſe parts from the Left hand towards the Right; as, *f*, *g*, for an Eaſt-Dial; but for a Weſt-Dial, from the Right hand towards the Left; then on *g*, as a Center, with 60 deg. of a Line of Chords,

describe a Semicircle, as, *f, d, b*; then take the Latitude of the place, 51° 32′, out of your Line of Chords, and set from *f*, to *d*, and likewise the Compl. of the Latitude 38° 28′, and set from *b*, to F; then draw *g*, F for the Equinoctial, and *g*, *d*, for the 6 of the Clock hour-line: The next thing will be to find the true hours distance upon the plain; and that is thus; Assume the height of the Style in inches and parts, as *g*, *i*, then it is but to resolve a right angled plain Triangle; for we have given *g*, *i*, the height of the Style in inches and parts, and the Angle at *i*, which the several hour-lines make with the 6 of the Clock hour line, to find each hours distance from the hour of 6, upon the Plain; which is found thus;

As the Tangent of 45°, or Radius,
Is to the height of the Style in inches and parts,
So is the Tangent of the several Angles at *i*, which every hour-line makes with the 6 of the Clock hour, allowing for every hours distance 15° 00′.

To the distance of each respective hour from 6, *viz.* *g*, *k*, *g*, *l*, &c. in inches and parts; but in this way there is an Inconveniency, and that is, if you assume the height of the Style too much, so by that means the extream hours will fall off the plain, that is, the hours of 11, and 4; and if you assume it too little, then the hour-lines fall too near together: But to avoid this Inconveniency, the best way is to proportion the Style to the plain; as thus; Assume any point upon the Equinoctial *g*, F, for

11 of the Clock, or half an hour paſt 10, as the point *k*; meaſure the diſtance between *g*, and *k*, upon a Scale of inches and parts; then in the Triangle *g*, *i*, *k*, right angled at *g*, we have given the ſide *g*, *k*, in inches and parts, and the Angle at *i*, 67° 30′, the Equinoctial diſtance for half an hour after 10, to find *g*, *i*, the height of the Style;

The Proportion is,

As the Tangent of 45°,
Is to the Inches and Parts contained between 6 of the Clock, and the point where half an hour after 10, falls, *viz*. *g*, *k*,
So is the Tangent Compl. of the hours diſtance from 6, 67° 30′,
To the height of the Style, in Inches and Parts, *g*, *i*.

As for Example. *Fig*.VI.

Let A, B, C, D, repreſent an Eaſt-Plain, *g*, F, the Equinoctial, and *g*, *d*, the hour of 6, as before; then let the point *k*, upon the Equinoctial, be aſſumed for half an hour after 10, to paſs through, ſo that by meaſuring the diſtance *g*, *k*, I find it to be 52 Inches, 6 10th. ſo that by the laſt Proportion, I find the height of the Style to be 21 Inches, and 8 10th. equal to *g*, *i*. Then far the hours diſtance on the Plain, Firſt, you may prepare a Table of the Equinoctial diſtance of each hour from 6, as before in the South-Dyal; which is done in the following Example, only to Hours: ſo that you will

Hours.		H. Dist. on the Equino. Dial.		H. Dist. from 6, on the Plain.	
		6	7		
06	06	00	00	In.	P.
07	05	15	00	05	09
08	04	30	00	12	05
09	00	45	00	21	08
10	00	60	00	38	01
$\frac{1}{2}$		67	30	52	06

will find the hours distance upon the plain, by the first proportion hereof, to be 5 Inches 9 10ths. for 7, and 5, and 12, 5, for 8, and 4, &c. Then take the Inches and Parts so found, out of the same Scale with your Compasses, and set from the hour-line of 6, upon the Equinoctial, to 7, 8, 9, 10, and likewise on the other side to 5, and 4, which is the true Hours-distance upon the Plain; then, if through those points you draw Lines parallel to the Hour of 6, they shall be the true Hour-lines for any East-Dial, they being numbred as in the Figure, &c.

The Style of this Dial may be a plate of Brass, or Iron, or of Wyre, and to stand upon the hour of 6, the upper edge thereof must be parallel to the Plain or Hour of 6.

How to draw a Vertical Declining Dial. *Fig.* VII.

I Shall not trouble you with the Rules for finding the Declination of a Plain; it being largly handled by several Authors; but only set down the Rules for finding the Requisites of a declining Dial, as also the Hours distance from the Substyle: The thing given, is the Latitude of the Place, and Declination of the Plain from the

the North towards the South, or East or West, the things required before the Hours-distance from the Subſtyle can be found, are,

First, The distance of the Subſtyle from the Meridian, or Hour of 12.

Secondly, The height of the Style above the Plain.

Thirdly, The Inclination of Meridians, or an Arch of the Equinoctial contained between the Meridian of the place, and Meridian of the plain.

Example.

Suppoſe in the Latitude of *London* 51° 32′, a Plain declines West, 16° 50′.

First, *To find the Distance of the Subſtyle from the Meridian.*

As the Radius,
Is to the Sine of the Declination, 16° 50′,
So is the Tangent compl. of the Latitude 38° 28′.
To the Tangent of 12° 57′, the Subſtyle-distance from the Meridian.

Secondly, *For the Height of the Style.*

As the Radius,
Is to the Sine compl. of the Declinat. 73° 10′.
So is the Sine compl. of the Lat. 38° 28′.
To the Sine of 36° 32′, the Styles Height above the Plain.

Thirdly,

Thirdly, *For the Inclination of Meridians.*

As the Sine of the Latitude 51° 32′,
Is to the Radius or Sine 90° 00′,
So is the Tangent of the Declination 16° 50′,
To the Tangent of 21° 8′, the Inclination of Meridians.

Thus having found the Inclination of Meridians to be 21° 8′, which converted into Time, is 1 hour, 24 min and ½; ſo that the Subſtyle will fall between 1 and 2 of the Clock, becauſe the Declination of the Plane is Weſtward; then to find the hour-Diſtances from the Subſtyle, you muſt make a Table of the Equinoctial Diſtance, as before; only whereas you took the Diſtance from 12, here you muſt count them from the ſubſtyle; thus: In the firſt Column ſet down the hours and halfs, and if you pleaſe, the quarters ſucceſſively, from the extream hour, which in This following Example is 7; and ſo proceed to the other Extream Hour, between the hours of 1, and a half, after 1, write Subſtyle; then in the ſecond Column ſet down the Equinoctial diſtance of each hour and half from the Subſtyle, thus; againſt 12, ſet the Inclination of Meridians 21° 8′, from which ſubſtract 7° 30′, for half an hour after 12, there remains 13° 38′, the Equinoctial diſtance from the Subſtyle, or half an hour after 12; then from 13° 38′, ſubſtract 7° 30′, allſo there remains 6° 8′, for 1: Then becauſe the diſtance between 1, and the Subſtyle is not half an hour, or 07° 30′, then ſubſtract 6° 8′, from 7° 30′, there reſts 1° 22′, the

the distance between the Substyle and half an hour past 1, on the other side of the Substyle; the rest are all found by continual Addition of 15° 00′, for each Hour, and 7° 30′, for half an hour; as in the Table.

Lat. North 51° 32′. Declinat. 16° 50′.		
Subst. Dist. 12° 57′. Stil. height 36° 32′. Incl. Mer. 21° 08′.		
Hours.	*Equinoctial distances.*	*True distance on the Plain.*
M. E.	d. m.	d. m.
05 07	83 52	79 46
½	76 22	67 50
06 06	68 52	57 01
½	61 22	47 59
07 05	53 52	39 12
½	46 22	31 59
08 04	38 52	25 38
½	31 22	19 57
09 03	23 52	14 46
½	16 22	09 55
10 02	08 52	05 18
½	01 22	00 49
Subst.		

Lat. North 51° 32′. Declinat. 16° 50′.		
Subst. Dist. 12° 57′. Stil. height. 36° 32′. Incl. Mer. 21° 08′.		
Hours.	*Equinoctial distance.*	*True distance on the Pla.*
M. E Subst.	d. m	d. m.
11 01	06 08	03 40
½	13 38	08 13
12 12	21 08	12 57
½	28 38	18 00
0 11	36 08	23 30
½	43 38	29 35
02 10	51 08	36 27
½	58 38	44 19
03 09	66 08	55 23
½	73 38	63 45
04 08	81 08	75 19
½	88 38	87 42
E. M.		

Then to find the true Hours distance from the Substyle on the Plain, the Proportion is,

As the Radius,
Is to the Sine of the Stiles height, 36 d. 32 m.
So is the Degrees and Minutes in the second Column,
To the Degrees and Minutes of the third Column, the true Hours distance upon the Plain.

Then to describe the Hour-Lines upon your Plain

First, Draw a Horizontal Line as A B, then near to A, let fall a perpendicular Line, as E, 12, for the Meridian, or 12 of the Clock hour-line; then with 60 d. 00 m. of your Line of Chords, upon E, as a Center, describe the Semicircle A *f* B, and from *f*, set the distance of the Substyle from the Meridian to *g*, *viz.* 12 d. 57 m. and from *g*, to *h*, set the height of the Style, 36 d. 32 m. and draw the Line E *g*, for the Substyle, and E *h*, for the Style; then from the Substyle at *g*, set the degrees and minutes in the third Column both ways; as if you take 3 d. 20 m. and set from *g* to *e*, for one of the Clock, and likewise 00 d. 49 m. from *g*, on on the other side to *e*, for half an hour after 1; and so of the rest, as in the Table: And then, if you lay a Ruler from E, to every one of those Points in the Semicircle, you may thereby draw the true Hour-Lines; then for the Style, it may be either a Plate of Brass or Iron, or Wyre, bowed

equal

equal to the Angle *a E h*, and set Perpendicular on the Substylar Line *E g*. (observe the Pattern of the Cock in the Scheme) and thus may the hours of any other declining Dial be exactly found, and put upon the Plain.

How to find the Distance of two Places in the Arch of a great Circle.

THere are several Varieties to be considered herein: I shall but briefly touch upon them; and shew how such as need it, are resolved by the Circular Lines on the Instrument.

1. two Places lie under the same Meridian, and on the same side the Equinoctial, and differ only in Latitude, then deduct the lesser Latitude out of the greater, and the Remainer is the distance in degrees; which being multiplied by 60, gives the distance in Miles: But if two Places have the same Meridian passing over them, and the one be South of the Equinoctial, and the other North, then the Sum of their two Latitudes is their distance in degrees; which bring into Miles, as before.

2. If two Places which differ only in Longitude, be propounded to find their distance, and both be under the Equinoctial, then substract the less Longitude from the greater, and the Remainer is the distance required in degrees, &c. But secondly, If two Places differ only in Longitude, and are not under the Equinoctial, but under some Parallel between the Equinoctial

 and

and one of the Poles, to find their distance, do thus; First, Substract the less Longitude from the greater, and then by a Table, knowing how many miles answer to a Degree of that Parallel, I multiply the Difference by the said number of Miles; and the Product is the Answer to the Question. But because such a Table may not be at hand, secondly, use this Proportion.

As the Radius,
is to the Cosine of their Latitude,
So is the Sine of half the Difference of their Longitude,
To the Sine of half their distance in degrees; which doubled, and multiplied by 60, gives the distance in Miles.

3. If two Places be proposed, which differ both in Longitude and Latitude, and this hath three Varieties; as,

1. If one Place be under the Equinoctial, and the other toward one of the Poles, then substract the less Longitude from the greater; and if the difference be 90 d. that also is the distance in degrees; but if the difference be not 90 d. then use the following Proportion:

As the Radius,
Is to the Cosine of the difference of Longitude,
So is the Cosine of the Latitude given,
To the Co-sine of the Distance in Degrees.

2. If the Distance of two Places be required, that have Difference of Longitude and Latitude

tudeboth; and are on one side of the Equinoctial; then work as in the following Example, which shall be for *London* and *Constantinople*. And suppose the Longitude of *Constantinople*, 54 d. 10 m. the Longitude of *London*, 20 d. 25 m. the Difference is 33 d. 45 m. the Latitude of *Constantinople*, 40 d. 56 m. the Latitude of *London*, 51 d. 32 m. Now to find their distance, you must use two Operations. First,

As the Sine of 90 d.
Is to the Co-tangent of one Latitude (which suppose *London*) 38 d. 28 m.
So is the Co-sine of the Difference of the Longitudes, which is 56 d. 15 m.
To the Tangent of a 4th. Arch, which in this Example will be 33 d. 27 m. Substract this 4th. Arch from the Compl. of the other Latitude, which is 49 d. 4 m. and the Remainer is 15 d. 37 m.

Then,

As the Sine Compl. of 33 d. 27 m. the fourth Arch,
Is to the Sine Compl. of 15 d. 37 m. the Remainer,
So is the Sine of the Latitude used in the first Operation, *viz.* 51 d. 32 m.
To the Co-sine of the Distance sought in degrees, which is 25 d. 20 m. And this multiplied by 60, gives 1520 Miles, the Distance from *London* to *Constantinople*.

3. And if the two Places propounded be one towards the North-pole, and the other toward the

the South, and have, as the last, difference of Longitude and Latitude) the very same Proportion as before, resolves this also, only with this Caution, that having found the fourth Arch, and thereby the Remainder, as in the last Example, then you must in this case add 90 d. to the Remainder, and use the Compl of the same to 180 d.

How to take the Altitude or Distance of any Object.

WHen you take the Altitude of any Object which you desire to know in Feet, Yards, &c. hang a String and Plummet on the Center-Pin, then hold up the Instrument, and by the Sights direct your Eye to the Object (as is shewed before in taking the Altitude of a Star) then the String and Plummet playing freely, note the Degree and Minutes cut by the String in the Limb of the Instrument; for that is the Angle of Altitude: then measure the distance between your standing and the foot of the Object, (if you please) in Feet, then by the Sines and Numbers on the Instrument, find the Height in Feet, thus;

As the Sine Compl. of the observed Angle,
Is to the measured distance in Feet,
So is the Sine of the observed Angle,
To the Height sought in the same Measure.

You

You must add the height of your Eye from the Ground, thereto. This needs no Example: But herein it is supposed the distance to the foot of the Object, is accessible, or may be measured: Therefore, secondly, Let the Altitude of an Object be required in Feet, whose Distance may not be measured, by reason of some Impediment, as a Ditch or River, or the like, then must you take an Angle of Altitude at two several Stations, which you may chuse at pleasure; we will suppose the first Station at C, in the Diagram A B D C; from whence, looking up to the Object at B, I find the String to cut 61 d. 26 m. whose Compl. is 28 d. 34 m. or the Angle ABC, I remove back in a right Line from C to D, 90 feet, and then looking up to the Object B, the String will cut 45 d. 17 m. whose Compl. is the Angle A B D, 44 d. 43 m. then I substract the Angle A B C, 28 d. 34 m. from A B D, 44 d. 43 m. and the Remainer is 16 d. 9 m. the Angle C B D, now I repair to my Instrument, and work out the Proportion thus;

As the Sine of 16 d. 9 m.
Is to the measured Distance C D, 90 feet,
So is the Angle at D, 45 d. 17 m.
To the Side C D, 230 feet.

2. As the Angle at A, 90 d.
Is to the Side C D, 230 feet,
So is the Angle at C, 61 d. 26 m.
To the Side B A, 202 feet. Unto which add the height of your Eye from the Ground, and you have the whole height of A B.

Again,

[illegible] If the Distance of two Objects be required without measuring between them, then you need not use a Thred and Plummet, but pin the Legs of the Sector upon the Center, & in one of the Legs put two Pins into the two Holes that are left for them at each end of the String; the Instrument being thus prepared, we will give this Example.

Let the Distance between D and B, be required. First, I set the Center of my Instrument (by some convenient Support) over D, and by the two Sights fixed in the Diameter, look to C, then I move the Sector Leg that hath the two Pins, till by the said Pins I see the Object C, by which I have the Angle at D, 45 d. 17 m. then I move from D to C, measuring D C, and set up my Instrument over C, and then (as before) by the Sights and Sectors Leg I look to the two Objects B and D, and thereby obtain the Angle at C, which is, 118 d. 34 m. and now I have the two Angles C and D, the Sum whereof is 163 d. 51 m. which subtracted out of 180°, leaves the Angle at B, 16 d. 9 m. Then I say,

As the Sine, 16 d. 9 m. the Angle at B,
Is to the measured Line D C, 90 feet,
So is the Sine of the Angle at C, or its Compl. to 180 d. 61 d. 26 m. (because above 90°)
To the Side D B, [illegible] feet, which was required.

F I N I S.

A Catalogue of 49 Stars of the firſt and ſecond Magnitude.

	Names of the Stars.	Longitude. d.	m.	Latitude. d.	m.		Right Aſcen. d.	m.	Declination. d	m.	
2	In the head of Andr.	00	52	25	42	N	357	58	27	20	N
2	in her Girdle.	25	54	25	58	N	012	54	33	[illegible]	N
2	in her Southern foot	09	44	27	47	N	026	04	40	46	N
2	Br. * in Aquial.	27	15	29	20	N	293	47	08	[illegible]	N
1	Capella.	17	23	22	51	N	073	09	45	[illegible]	N
2	in his right ſhoulder,	25	28	21	25	N	084	06	44	50	N
1	Arcturus.	19	47	31	00	N	210	18	20	55	N
1	the G.Dog * Sirius.	09	47	39	32	S	097	43	16	17	S
2	the L.Dog * Procion	21	23	15	57	S	110	38	06	[illegible]	N
2	Cete the Whales Jaw	09	52	12	36	S	041	23	02	48	N
2	the Southern.	28	02	20	43	S	006	59	19	42	S
2	Nor.Cr. the bright *	07	45	44	25	N	230	26	27	49	N
2	in the Swans tayl.	00	58	59	57	N	307	37	44	10	N
2	Gemini's head of Ca.	15	44	10	02	N	108	29	32	32	N
2	Gem. head of Pollux	18	47	06	38	N	111	25	28	45	N
2	in the bright foot.	04	34	06	48	S	094	[illegible]	16	37	N
1	Hydra's heart.	22	49	12	23	S	137	57	[illegible]	[illegible]	S
1	Lions heart.	25	21	00	26	N	147	47	[illegible]	30	N
1	Lions Tail.	17	09	12	16	N	173	09	16	20	N
2	Li.br. * in his creſt.	25	01	08	45	N	150	31	21	26	N
2	Li.br * in his Loin	06	50	14	18	N	164	14	22	[illegible]	N
2	Northern Ballance.	14	55	08	33	N	224	59	08	[illegible]	N
2	Southern Ballance.	10	39	00	25	N	218	21	14	39	S
1	Bright * i'th' Harp	10	49	61	47	N	276	29	38	[illegible]	N
2	Orion's right ſhould.	24	19	16	06	S	084	20	07	17	N
2	in his left ſhoulder.	16	29	16	52	S	077	00	06	[illegible]	N
1	Orion's foot Rigel.	12	19	31	10	S	074	47	08	[illegible]	S
2	firſt of the Belt.	17	52	23	36	S	078	54	00	[illegible]	S
2	ſecond of his Belt.	18	56	24	34	S	079	57	01	26	S
2	third in Orion's Belt.	20	06	25	21	S	081	03	02	09	S

	Names of the Stars.	Longitude,		Latitude.			Right Ascense.		Declination.		
		d.	m.	d.	m.		d.	m.	d.	m.	
2	in his Thigh-ſheat.	24	57	31	08	N	342	06	26	22	N
2	Br. * in the Wing.	19	02	19	24	N	342	13	13	29	N
2	Br. * i'th' lower W.	04	43	12	37	N	359	12	13	26	N
2	Perſeus in his ſide.	27	17	30	05	N	045	04	48	39	N
1	Scorpion s Heart.	05	18	04	26	S	242	29	25	36	S
.	in his Forehead Nor.	28	40	01	06	N	236	40	18	49	S
2	Serpent's neck br. *	17	33	25	33	N	032	09	07	20	N
1	Bulls Eye South.	05	18	05	30	S	064	24	15	50	N
2	Bulls Northern Eye.	03	59	02	36	S	062	26	18	33	N
2	his Northern Horn.	18	05	05	20	N	076	31	28	20	N
2	Virgins Spike.	19	22	01	59	S	197	06	09	27	S
2	Great Bears ſhoulder	10	41	49	40	N	160	56	63	28	N
2	Next under it.	14	51	45	05	N	160	32	58	05	N
2	Br. * hinder Thigh.	25	57	47	08	N	174	06	55	30	N
2	in his Rump Aliot.	04	19	54	17	N	189	54	57	43	N
2	Middle in the Tail.	11	04	56	21	N	197	42	56	37	N
2	The laſt in the Tail	22	20	54	24	N	203	41	50	57	N
2	The Pole-Star.	24	09	65	59	N	009	[illegible]	87	36	N
2	Little Bears ſhoulder.	08	28	72	48	N	222	40	75	38	N

ERRATA.

PAge 3. to the Reader, line 15. read *glanced*. p. 12. l. 17. r. 1758. p. 13. l. 11. r. 23. p. 16. l. 23. r. *Suns Place*. p. 17 l. 9. r. 40 m. l. 12. r. 40. p. 18. l. 8. r. *Signes*, p. 23. l. 20. r. 64 d 26 m. l. 21. r. 18 m. p. 32. l. 8. r. 17th. Prob. p. 33. l. 14. r. 10 h. 8 m. p. 41. l. 5. r. 29 d. p. 45. l. 6. r. *Diſtance*. p. 57. l. 5. r. *under moveable*, for *Ecliptic or upper*. p. 75. l. 32. r. 12. p. 76. l. 15. r. *Lin*. p. 79. l. 5. r. *Second*, l. 6. r. *First*. p. 82. l. 17. r. *r*. p. 86. l. 21. r. 82 d. 00 m. l. 22. r. 29 m. l. 23. r. 7 d. 31 m. p. 78. l. 5. r. *Perpendic*. p. 88. l. 17. r. 111 d. 58 m. l. 19. r. 63 d. 2 m. p. 95. l. 30. r. 14 m. p. 101. l. 3. r. 14 m. p. 102. l. 10. r. 104. p. 105. l. 26. r. 3 d. p. 107. l. 22. r. *f*. p. 117. l. 15. r. *k*. p. 118. l. 4. r. 79. p. 119. l. 6. r. 3 m. l. 10. r. 9 m. l. 13. r. 51. p. 120. l. 5. r. 80 d. l. r. 56 m. p. 118. l. 19. r. *Significator*.

The Reader is deſired in correcting the Errata, to obſerve that the Sheets *L* and *M* have one and the ſame Figures at the Head of the Pages.